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**PREVENTION OF
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PREVENTION OF INFECTIOUS DISEASES

BY

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TO
DR. HERMANN M. BIGGS
IN RECOGNITION OF THE IMPORTANT PART
HE HAS TAKEN IN THE ADVANCEMENT OF
SANITARY SCIENCE, THIS BOOK IS DEDICATED

PREFACE

In the preparation of this book it has been my aim to deal with the subject from a practical standpoint and to present the latest knowledge relative to the transmission of infectious diseases and the means by which they may be prevented, and so far as possible to prove the fallacy of certain theories regarding this subject which have long been accepted and which aid in the extension rather than the prevention of these diseases.

While the views I have expressed are the result of my own experience and personal investigation, I am quite sure that they are in harmony with the belief of the majority of practical sanitarians.

A. H. D.

New York.

CONTENTS

CHAPTER	PAGE
I. GENERAL CONSIDERATION	1
II. CLASSIFICATION OF INFECTIOUS DISEASES . .	23
III. MARINE SANITATION	36
IV. SMALLPOX	58
V. YELLOW FEVER	79
VI. TYPHUS FEVER	101
VII. CHOLERA	109
VIII. PLAGUE	127
IX. DISINFECTION	139
X. DISINFECTANTS	153
XI. DISINFECTION IN CONNECTION WITH APART- MENTS OF THE SICK, ISOLATION AND DIS- CHARGE OF THE PATIENT	212
XII. THE THERMOMETER	222
XIII. THE MOSQUITO	234

THE PREVENTION OF INFECTIOUS DISEASES

CHAPTER I

GENERAL CONSIDERATION

HISTORY furnishes but little reliable information regarding the methods or means employed in early times for the prevention of disease, although even prior to the Christian era, the importance of cleanliness and fresh air in the preservation of health was fully recognized. The Levitical laws relating to public sanitation, which are referred to in the Bible, were based chiefly on the observance of cleanliness, and although many centuries have elapsed since their enactment, their value in this direction is still maintained. This cannot be said of various other means employed for this purpose during the early period of the Christian era, many of which were farcical, and included the burning

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PREVENTION OF INFECTIOUS DISEASES

of magic powders, incantations, etc. Methods which succeeded these were almost as worthless, and were often of the most drastic character; houses were burned, vessels were held in quarantine for two or three months with their cargoes spread about their decks for so-called purification, and as late as the eighteenth century, vessels carrying cargoes from presumably infected ports were sunk by official order to prevent the introduction of infectious disease into seaports. Although the means used for this purpose gradually increased in efficiency, it was not until the researches of Pasteur and Koch were published, and the germ origin of the infectious diseases became known, that sanitation was placed on a scientific basis, and a new era was inaugurated in this important work. Since then the discovery of many specific organisms, and the accumulation of accurate knowledge regarding the cause of the infectious diseases, and the media by which they are transmitted, have placed in our hands means by which outbreaks may be prevented, or brought under prompt control. We now deal with facts and not theories, and there is no justification for the employment of unscientific or inefficient measures in the protection of the

GENERAL CONSIDERATION

public health against infectious disease, nor should theories be accepted, which careful scientific research and practical experience have proven to be erroneous.

The knowledge which has been gained in late years regarding this subject clearly indicates, that some of the generally accepted theories relating to the manner in which infectious diseases are transmitted are false and misleading. The belief has long existed that infectious diseases are transmitted not only directly from one person to another, but commonly through the medium of articles or materials known as "fomites," which are believed to be capable of retaining infectious germs in the active state. These include clothing, bedding, baggage, cargoes of vessels, money, rags, etc. This belief, as medical history will show, is very old, and has dominated all health regulations, whose object is to guard against outbreaks of infectious disease. Curiously enough there has been but little satisfactory or definite scientific evidence presented to uphold the fomites theory, and its chief support lies in the fact that it offers a plausible explanation for the occurrence of outbreaks of infectious disease, the origin of which is unknown.

PREVENTION OF INFECTIOUS DISEASES

Even a superficial investigation lays bare the weakness of this theory; however, the natural desire of those having in charge the public health to be on the safe side, and to assume no chance in dealing with outbreaks of infectious disease has been largely responsible for the delay in exposing the fallacy of this belief. Practical sanitarians who have given the matter careful study are slowly but surely accumulating conclusive proof that most infectious diseases are only in very rare instances transmitted by clothing and other textile fabrics.

No one who is familiar with this subject doubts that under certain unusual conditions infection may be transmitted in this manner; however, the fomites theory is not confined to special instances, or particularly in connection with articles belonging to the sick, but in a general way regards the clothing and effects of well persons, the baggage and cargoes of vessels, money, rags, etc., as common media of infection. How vulnerable this theory is may be illustrated in the case of yellow fever. Until a comparatively recent time, fomites were regarded as a common means of infection in this disease; it was believed that not only the clothing of the patient, but also the

GENERAL CONSIDERATION

clothing of well persons who had been exposed to the patient, or had been in an infected area constituted an important factor in the transmission of yellow fever. Now we have conclusive proof, that even the clothing, bedding, discharges, etc., of those attacked with this disease are harmless, and do not constitute a medium of infection, and that yellow fever is transmitted only by a variety of the mosquito known as the "stegomyia."

The same careful investigations which have presented reasonable evidence that fomites rarely act as a medium of infection have also shown that infectious diseases are almost always transmitted directly from one person to another, or by insects, food or drink. Besides, the great danger from mild, ambulant, irregular and unrecognized cases as a source of infection has become better understood, and there is abundant proof to show that such cases are usually responsible for outbreaks of infectious disease, the origin of which cannot be explained.

Practical investigation and bacteriological research have more recently presented indisputable evidence that well persons, known as "carriers," transmit certain diseases without exhibiting any symptoms themselves. This oc-

PREVENTION OF INFECTIOUS DISEASES

occurs particularly in typhoid fever, cholera, and diphtheria. The importance of this evidence cannot be overestimated as it offers a rational explanation for the appearance of outbreaks, even when the presence of typical, mild or ambulant cases of disease may be reasonably excluded.

Furthermore in connection with the fomites theory it is generally believed that the specific organism of an infectious disease may remain active for months, or years in clothing, toys, etc., which have been laid away, and that when the latter are again exposed may act as a medium of infection. Instances of this character are frequently cited in families, where certain infectious diseases have appeared particularly among children, which apparently can be accounted for in no other way. While this explanation in some instances may seem very plausible and possibly in some rare instances may be accurate, it does not by any means exclude the probability that it is a coincidence, and that the disease was contracted in the usual way. Children in play and otherwise are frequently in close and prolonged contact with mild cases of measles, scarlatina and diphtheria, which are unrecognized, and the person af-

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GENERAL CONSIDERATION

fectured is conscious of little or no discomfort, but still may be the means of transmitting infection to others. The author has proven in a number of such instances, that the disease was contracted not by clothing which had been laid away, but by personal contact.

Theories relating to the transmission of infectious disease unsupported by reliable evidence cannot be accepted by sanitary science; unfortunately, there has been a tardy recognition of this fact, which has seriously interfered with progress in establishing the true means by which infectious diseases are transmitted.

An abundance of practical and scientific evidence has been presented to show that fomites rarely transmit disease. The following may be cited from the author's experience: During 1892, outbreaks of typhus fever and smallpox occurred simultaneously in New York City. The epidemics continued until the early part of 1893, and included almost a thousand cases of smallpox, and over seven hundred cases of typhus fever. The corps of physicians and employés connected with the Bureau of Infectious Diseases of the Department of Health at that time numbered over eighty persons, and consisted of diagnosticians, medical inspectors,

² ⁷ scarlet fever
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PREVENTION OF INFECTIOUS DISEASES

ambulance drivers, helpers, etc., who were constantly exposed to, and frequently in close and prolonged contact with, cases of these diseases. No gowns were used for protection, and the persons above referred to went frequently and freely to and from their homes, but in no instance did they transmit typhus fever or small-pox to any of their families or friends, among whom there were undoubtedly those who had not secured the protection of vaccination. During the outbreak above referred to, the most thorough investigation was made in each case of these diseases reported to the Department of Health to determine their origin, and with comparatively few exceptions, it was shown that they were transmitted directly from one sick person to another. In many instances it was found that other cases of the same disease existed in the family, or among the relatives or friends of the sick, which had been unrecognized, and the individuals had been treated for some other ailment. These results are familiar to all diagnosticians who officially deal with infectious diseases.

In 1897, the author made a personal investigation both in this country and in Egypt regarding the alleged danger from rags as a

GENERAL CONSIDERATION

medium of infection. Egyptian rags consist principally of the worn-out garments of the natives, which usually consist of one piece, and as a rule are worn next the skin. These rags are largely used in the manufacture of paper in this country. They are collected throughout Lower Egypt, and are forwarded to Alexandria in rope crates, and there are carefully picked over and sorted out according to color, etc., by women and children. Although some form of infectious disease is almost always present in Egypt, the carefully prepared statistics of the British Sanitary Officers, who were in charge of this work at the time, presented no evidence that those who were daily in close and prolonged contact with these rags in the sorting rooms, contracted infectious disease through this source. Practically the same history was obtained in the investigation of this subject among paper manufactories in the United States. Neither is there any reliable proof to show that the families of those who deal in second-hand clothing, and who generally live in the same, or in an apartment adjoining where the clothing is kept, contract infectious diseases any oftener than any one else.

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PREVENTION OF INFECTIOUS DISEASES

4!! The author has carefully investigated the influence of money as a medium of infection. The results show that those who are constantly handling money, such as bank officials, do not contract infectious diseases any oftener than others. The Treasury Department at Washington furnishes exceedingly valuable information on this subject. Here large quantities of filthy and offensive paper money are being constantly handled and rehandled prior to destruction, and not the slightest evidence has been presented at that place to show that infectious diseases are transmitted by this material. Than this, no more important or conclusive evidence on this subject can be presented. The results of a careful bacteriological study of this subject, by Warren W. Hilditch, of the Sheffield Laboratory, Yale University, published in the *Popular Science Monthly* of August, 1908, add confirmation to the author's statement, that money is a medium of infection only in rare instances. The fact that bank officials and others, who are constantly handling money, and those employed in paper manufactories, occasionally contract an infectious disease, is not scientific evidence nor proof that either money or rags constitute a medium of infection. The persons

GENERAL CONSIDERATION

who handle these things are subject to the same outside exposure that others are, and may contract infectious disease in the ordinary way. This simple fact is too often forgotten in the consideration of this phase of the question.

It may be further stated that careful investigation has also shown that cargoes of vessels do not act as a medium of infection, and unless there is a specific reason for it, they should not be disturbed in instances where an infectious disease appears on shipboard.

More recent proof that persons and not things transmit disease is presented by the careful and systematic examination of school children. It is a common belief that the marked increase in the number of cases of diphtheria, measles and scarlatina, which usually occur at the commencement of the school year is largely due to the transmission of these diseases by the clothing of well children in whose homes some form of infectious disease exists or has recently existed. Some years ago the Department of Health of the City of New York, established a school corps, consisting of medical inspectors, whose duty involves a daily examination of the children in the public schools. Indisputable evidence was soon presented to

PREVENTION OF INFECTIOUS DISEASES

show that children with various infectious diseases in a mild or unrecognized form are constantly present in school. Slight sore throats have proven to be the local manifestation of scarlatina; bacteriological examinations of throat and nose discharges have shown the presence of the bacilli of diphtheria in children who are apparently well, and, furthermore, presumably simple coryzas are found to be the local manifestation of measles. These conditions are not occasionally, but commonly found, and the results are exactly the same as those found by other municipal departments of health, whose regulations call for this same character of school inspection. These facts offer a reasonable and scientific explanation for the increase in the number of cases of infectious diseases at the beginning of the school year.

These statistics have a distinct and important bearing on the question of closing schools in communities, where outbreaks of infectious diseases occur. Schools are frequently closed because it is believed that disease infection is transmitted among the children by the clothing of those who are well. Our present knowledge, however, does not justify this action. Infectious diseases which occur among school

GENERAL CONSIDERATION

children are caused in the ordinary way, either by direct exposure outside or inside of the schoolhouse. In the latter instance particularly it is usually due to the presence of mild, convalescent or unrecognized cases. This has been conclusively proven by the experience of the various school corps already referred to. The proper and logical means of dealing with this subject may be summed up in a very few words. If care is taken that actual cases do not enter a school, there is no special reason, why it should not remain open; furthermore, children who remain in school and are subjected to careful surveillance are probably better protected than those who are out of school and about the street, and mixing indiscriminately with others, particularly if the outbreak is widespread.

The proper means of preventing the entrance of cases of infectious disease into a school consist in a thorough inspection of all children on their arrival at school each morning. This should fully include a careful examination of the throat, face and hands, a mental note of the general appearance of each child should be made and in all suspicious cases the thermometer should be used. The detail of this examination is a matter which health officials must

PREVENTION OF INFECTIOUS DISEASES

decide in each instance in dealing with these conditions under their jurisdiction. If small-pox is present vaccination should be insisted upon; if diphtheria is to be feared the question of immunization must be considered. The value of a careful daily inspection of school children during an outbreak of infectious disease applies to private schools as well as public ones. Whatever may be the character of the examination in these emergencies it should be in the hands of physicians and not school teachers. While many of the latter under careful medical tuition may be able to detect early or suspicious symptoms of disease, the majority of them are not competent to carry out this important means of protection.

In connection with this subject reference may be made to aërial infection, or the theory that disease may be transmitted long distances from the seat of infection by the air. Cases have been cited where it is alleged that infection has been transmitted in this way for half a mile or more. Satisfactory scientific proof, however, of this is wanting, and it is the author's opinion that it does not take place except in the immediate vicinity of the patient and then only in the case of a few diseases.

GENERAL CONSIDERATION

The knowledge that infectious diseases are transmitted by persons rather than things, insures far greater protection to the public health for it clearly indicates the imperative necessity for careful and exhaustive investigation and inspection, whenever outbreaks of infectious disease occur, to discover their origin, and it no longer justifies the conclusion that in some undetermined way outbreaks of infectious disease are caused by fomites. The latter belief stimulates carelessness, and in the past has been largely responsible for the extension of infectious disease, which careful inspection would oftentimes have prevented.

It is exceedingly important to know at what stage of an infectious disease the danger of its transmission to others is greatest. To obtain even approximately definite facts in regard to this point has thus far been very difficult, besides the specific organisms of some of the more common of these diseases, such as measles and scarlet-fever, have not yet been identified. However, the facts we already possess bearing on the means by which infectious diseases are transmitted seriously discredit the theory that desquamation is a potent factor in the transmission of infection, particularly in

PREVENTION OF INFECTIOUS DISEASES

scarlet-fever and measles, and to those who have given this subject careful study, it would not be a surprise if in the near future proof were presented of the practical harmlessness of desquamation in connection with these diseases, and that the period of infection is rather during their early or active stages, and later if discharges are present.

A careful study of the means by which infectious diseases are transmitted clearly defines the course which should be followed in their prevention and control. In general this consists in a thorough and exhaustive investigation to determine the origin of outbreaks, to discover the whereabouts of those who are infected and to secure their strict isolation, and also to detain or in some manner keep under observation, those who presumably have been exposed to infection and who are known as suspects. This procedure applies to the management of cases of infectious diseases either at home or in hospital. The danger and the difficulty of treating cases of infectious disease in dwelling or apartment houses, hotels, etc., lie in the fact that strict isolation is not usually or easily secured. However, it is possible to procure this if proper attendants

GENERAL CONSIDERATION

are provided and modern sanitary regulations are strictly enforced.

A belief exists, that physicians who attend cases of infectious disease frequently act as a medium of infection. Physicians instinctively know that this rarely occurs. The real danger of transmitting infection, through the medium of the physician or nurse or others who are in charge of cases of infectious diseases is by the hands rather than by the clothing, while it is true that in the care of such cases discharges may be expelled upon the clothing of those in close contact with the patient, and may in some unusual instances be responsible for the transmission of the disease. This explanation, however, is largely theoretical, and there is good reason to believe that the clothing plays an exceedingly unimportant part in the transmission of disease, and also that infection is more frequently transmitted by the hands. The appearance of another disease in a hospital ward is commonly due to the presence of a previously undiscovered case of this kind.

If it is deemed necessary on the part of a physician to employ some form of covering in any special instance, a clean bed sheet can be so deftly arranged as to cover the

PREVENTION OF INFECTIOUS DISEASES

front of the body and the arms. So far as nurses are concerned, they should always be provided with some outside dressing for the front of the body, not only to guard against the possible danger of transmitting infection by the clothing, but also to maintain cleanliness. If a head covering is called for one may be easily improvised by tying knots in the four ends of a napkin—sheets and napkins are always available and gowns are not. After the former are boiled for fifteen minutes they may be added to the general laundry without the least danger of transmitting infection. This insures a fresh and clean covering whenever it is required. An attempt on the part of a physician to carry with him a sufficient number of fresh gowns to meet all the emergencies which may occur in his daily practice would be absolutely impractical, besides, in the manner in which gowns are frequently employed, they would from a theoretical standpoint act as a medium of infection rather than a protection.

ette The thorough use of soap and water is far more effective in preventing the transmission of infection by the hands, than the so-called disinfection with carbolic acid, bichloride of mercury, etc., commonly employed in the sick room

GENERAL CONSIDERATION

and hospital. Soap and water with the aid of the nail brush clean the hands, whereas the practice of dipping them for a moment in a disinfecting solution, neither cleans nor disinfects them. It requires an immersion of at least half a minute in a 1-1000 solution of bichloride to kill organisms on the surface; to employ this after the hands are cleaned is undoubtedly an additional safeguard.

Protection against cases of infectious disease treated in dwelling or boarding houses, hotels, etc., always depends on strict isolation of the patient.

This same rule also dictates the arrangement of a hospital for the care of infectious disease, i. e., to insure strict isolation of the various groups or classes of infectious disease. The theory that they may not be treated under the same roof is erroneous, and is not in harmony with our present knowledge of this subject. It is required, however, that the different groups of infectious disease shall be kept absolutely apart from each other, that they shall have separate facilities in the way of water-closets, baths, sinks, etc., that they shall have separate eating utensils which must be sterilized after being used and the patients shall be

PREVENTION OF INFECTIOUS DISEASES

fed in their own apartments, and for the various reasons already referred to shall have a separate group of nurses.

The danger of transmitting the infectious diseases by the hands, may be reduced to a minimum by the use of rubber gloves worn at the time of the examination of the patient, particularly when discharges are dealt with. Rubber gloves for this special purpose are now manufactured in a most effective and practical style. They are thin and tough, and may without much injury be disinfected with boiling water.

A public health official should be practically familiar with the infectious diseases, and with the means by which they are transmitted from one person to another, and he should not accept theories relative to the latter unless they are supported by scientific evidence. He must have the courage of his convictions in his efforts to protect the public health and should carry out only such measures as are reasonable and practical. Attempts to secure complete safety by unjustifiable or spectacular methods usually defeat the end in view, and are not in accord with modern sanitation.

Infectious diseases oftentimes cannot be

GENERAL CONSIDERATION

promptly diagnosed. Failure to do this does not reflect upon the ability of a physician or health official, for cases of this character frequently do not disclose their identity until a later period and then probably only irregularly so. A hasty and faulty diagnosis reached for the purpose of making an early or definite statement is not infrequently the cause of an extension of the disease, which would not have occurred, if the suspected case had been promptly isolated and kept under careful observation. A health official who follows modern methods will understand that a bacteriological examination now plays an exceedingly important part in the diagnosis of infectious disease, particularly in obscure cases, and that it should be employed whenever it is necessary.

Success in public health work particularly in the prevention of infectious disease is frequently obstructed by attempts to follow specific rules and regulations in the management of outbreaks, etc., instead of being governed by the principles of sanitary science, a practical familiarity with which will enable a health official to cope intelligently with any condition or emergency which may present itself. Specific rules and regulations never accurately fit all

PREVENTION OF INFECTIOUS DISEASES

cases, and if followed tend to make a health official an automaton. Whereas, if the principles upon which sanitary science is founded are fully understood and acted upon, but comparatively few rules or regulations are necessary. A policy of this kind, which deals in a practical manner with all measures relating to the public health, causes the minimum amount of annoyance to the public and to commerce. Unfortunately this receives too little attention.

CHAPTER II

CLASSIFICATION OF INFECTIOUS DISEASES

Isolation—Treatment of Suspects, etc.

FOR practical purposes the infectious diseases may be divided into three classes: *First*, smallpox, cholera, plague, typhus fever and yellow fever, known throughout the world as quarantinable diseases; *Second*, diphtheria, scarlatina, measles and varicella; *Third*, the other infectious diseases such as typhoid-fever, tuberculosis, etc. Although the latter group are not as readily transmitted from one person to another as are diseases of the first and second class, nor subjected to such definite quarantine regulations, it is necessary that some means be taken to prevent their extension.

With the exception of smallpox, diseases of the first class are usually regarded as imported, and it was to guard against their introduction into seaports, that the first quarantine was

PREVENTION OF INFECTIOUS DISEASES

established in Venice in 1348. History furnishes authentic evidence that these diseases were known and described long before the Christian era. Since then their frequent appearance in different parts of the world has caused great loss of life; this, however, has not occurred in recent years where modern sanitary methods have been in operation.

The serious mortality, which frequently accompanies diseases of the first class, and the rapidity with which they often spread if not properly dealt with, call for their prompt and strict isolation. For this reason patients should not be allowed to remain in dwelling houses or hotels, or on shipboard if it is possible to remove them to a hospital or some place specially provided for their care.

As diseases of the first class are commonly carried from one part of the world to another by ships, they will be specially considered in subsequent chapters in connection with marine sanitation.

While diseases of the second class are very infectious, and belong to all parts of the civilized world, and are more or less constantly present in large towns, they are not generally regarded as so serious a menace to the public

CLASSIFICATION

health. This is a grave mistake, as the complications and sequelæ of measles, diphtheria and scarlet-fever add greatly to their danger and often involve a large mortality. Diseases of the second class occur principally among children, who as a rule are treated in their own homes, where proper quarantine regulations are not usually enforced. However, whether in town or on shipboard, these cases should always be carefully isolated, for there can be no doubt that carelessness in this respect is the chief cause of the continued presence of these diseases. As evidence of this, a very marked diminution is noticed in the number of cases of diseases of this group in communities where school children are subjected to careful official examination.

While diseases of the third class are not as readily transmitted to others, as those of the first and second class, it is necessary that some special means be taken to prevent their extension. For instance, in typhoid fever, care must be taken to prevent the transmission of infection by discharges from the intestinal tract; whereas in tuberculosis the sputum is the chief medium of infection. While the isolation of cases of this class, particularly

PREVENTION OF INFECTIOUS DISEASES

tuberculosis, is not usually enforced, its value in limiting their extension is nevertheless unquestioned, and there can be no doubt that the isolation of tuberculosis patients would be the most effective and practical means of exterminating or limiting the extension of this disease.

It is presumed that in cities and large towns, a hospital for the reception of cases of infectious diseases is provided. In small communities, however, no such accommodation is usually supplied, and even patients suffering from some one of the diseases of the first class are frequently treated in their own homes.

The proper isolation of a case of infectious disease involves confinement in an apartment, where in the strict sense of the word, the patient can be kept apart from all others, and under the care of competent nurses, who faithfully carry out the directions of the attending physician. Neglect to properly enforce this rule frequently occurs, when the patient is treated at home, and it is almost always responsible for the extension of the disease. For this reason it is not regarded as satisfactory or practical to treat diseases of the first class, and in some instances diseases of the second class, outside of a hospital, or a place specially

CLASSIFICATION

prepared for their reception. Where hospitals are not available for this purpose, a temporary structure of wood, galvanized iron, or some other material may be quickly erected at a small expense. A tent offers an exceedingly valuable means of isolating cases of infectious disease. During the outbreak of typhus fever in New York City during the winter of 1892-93, many cases were isolated and treated in tents, and although the weather was very cold, the mortality among the patients cared for in this manner was less than among those treated in the hospitals. In addition to the protection, which this method affords, a better chance of recovery is offered the patient, when placed under the care of those who are constantly dealing with such cases. There is no good reason to believe that all cases of infectious disease would not be benefited by judicious open air treatment.

The appearance in a community of a case of infectious disease, particularly of the first class, requires that certain persons who are known or presumed to have been exposed to the sick and designated as suspects shall be kept under observation, in order that the appearance of secondary cases may be promptly detected.

PREVENTION OF INFECTIOUS DISEASES

These persons may be divided into two groups: The first consists of members of the patient's family, or others who occupy the same house with him; second, those who have been exposed, but who reside in other places. In dealing with the first group of suspects, particularly where they have been exposed to diseases of the first class, various methods are followed in regard to detention, observation, etc., some of which are unreasonable and unjustifiable. As the danger of contracting the disease comes almost entirely from direct exposure to the patient, and not from clothing, etc., there is no logical reason so far as the public is concerned, why members of a family in whose house a case of infectious disease exists should not pursue their ordinary duties if they are kept under careful daily observation (including the use of the thermometer in order to promptly detect a deviation from a normal condition), and the patient is properly isolated. The uncertainty of the isolation from the fact that members of the family often surreptitiously visit the patient, when he is treated at home and is not continually under the observation of competent nurses or attendants makes this group of suspects more of a menace to the public

CLASSIFICATION

health than the second group. To hold suspects in quarantine often seriously interferes with the family revenue, as the enforcement of this regulation frequently involves a detention at home for a number of weeks. The possible chance of an infectious disease being transmitted by the clothing of the nurse, who is in close and prolonged contact with the sick, would be removed by a change of garments before leaving the apartment.

The second group of suspects are those who have been exposed to a case of infectious disease, but do not live in the same house with the patient. Their observation and care present no such complications as may occur in dealing with the first group of suspects, and as a rule it is only necessary that they be kept under careful daily observation for the period of incubation of the disease dating from the last known exposure.

The most effective protection of the public health against suspects depends chiefly upon a careful daily examination of the latter for the required period. The thermometer constitutes a most valuable aid in this examination, as it will indicate an abnormal condition and detect a mild or ambulant case, when a visual examina-

PREVENTION OF INFECTIOUS DISEASES

tion secures no evidence of it. (See Thermometer.)

When individuals or small groups of persons are under observation, the daily examination is a simple matter, but in factories, etc., where large numbers are involved, the examination requires considerable time and care. An accurate list of all employés should be obtained and every one carefully examined either at his place of business or at home. Those who are found to be indisposed, or those whose temperatures are above the normal register, should at once be isolated, at least until the presence of an infectious disease can be excluded. Under this method of surveillance secondary cases are as a rule promptly detected—an exceedingly important factor in preventing the further extension of the disease. Suspects who show an elevation of temperature, or present suspicious symptoms during inspection, commonly attribute these variations from the normal condition to some simple cause. Explanations of this kind should never be accepted in lieu of prompt isolation and observation. Even on land it is sometimes justifiable to quarantine or detain under constant observation, suspects who have been exposed to diseases of the first

CLASSIFICATION

class and who are not responsible, and have no home or definite address, and who there is reason to believe will not report for examination.

The early detection and isolation of cases of infectious disease are even more important on sea than on land, particularly on vessels carrying third class, or steerage passengers, who are of different nationalities, are poor and ignorant and are brought together in large numbers in necessarily restricted and often badly ventilated apartments. The prompt isolation of a case of this character among this class goes far towards preventing the further extension of the disease, and in various ways diminishes the delay and expense to the vessel, its passengers and crew on arrival at quarantine.

Passengers and crews instinctively know that sickness among them may in some way interfere with their prompt release at quarantine, and therefore reluctantly give information regarding their ailments, and frequently attempt to conceal them. Furthermore, mild cases of disease may occur without causing any unpleasant or noticeable symptoms to the person involved.

In instances where a vessel has come from an infected port, or where a case of infectious

PREVENTION OF INFECTIOUS DISEASES

disease, or a suspicious case has occurred during the voyage, or a death has occurred in transit, the cause of which is not definitely known, the same careful inspection above referred to should be made of all on board, both passengers and crew, particularly if steerage passengers are present.

There is always a temptation on the part of the ship's surgeon in the presence of a suspicious case to make a prompt and definite diagnosis, even if reasonable doubt exists. This sometimes proves to be a very serious mistake, because it may return to the general apartment a person who later is found to have an infectious disease. For this reason it is far better and safer to isolate a suspect, until the vessel arrives at quarantine, or at least until a deliberate and definite diagnosis can be made and the existence of an infectious disease excluded. The diagnosis of smallpox, for instance, should always be made on the character of the eruption, and not on the constitutional symptoms—the latter in some cases may be practically absent or not well marked. Still, the author has frequently seen cases of smallpox on shipboard diagnosed as noninfectious, and allowed to remain in the general

CLASSIFICATION

apartments, because there were no marked constitutional symptoms present. The proper isolation of these cases even as suspects would have prevented an extension of the disease, and also a serious delay to the vessel, its passengers and crew, as well as great expense to the ship's owner. Extreme care at sea in the isolation of cases of infectious diseases and suspicious cases, the careful examination of those who have been exposed, and an unwillingness to make a definite diagnosis unless the character of the case is positively determined, reflect great credit upon a ship's surgeon and stamp him as a faithful and valuable medical officer.

Steamship companies are becoming more and more impressed with the great advantages secured by the early and careful isolation of cases of infectious diseases and suspicious cases, which occur on shipboard, and in the building of new passenger vessels have constructed isolation wards, which are distinct from the general hospital. This constitutes a very valuable means of preventing secondary cases. If this arrangement does not exist on vessels where well-marked or suspected cases of infectious disease occur, the ship's surgeon should select for the isolation of the case, an apart-

PREVENTION OF INFECTIOUS DISEASES

ment where good outside ventilation can, if possible, be secured, preferably at either end of the vessel, and not in the center of it along the line of travel. He should also select some responsible persons, a steward or stewardess, for instance, if nurses are not available, who can be depended upon to take charge of the patient, to maintain strict isolation and to carefully obey all orders given by the ship's surgeon relative to the care of the case. The captain and other nonmedical officers of a vessel frequently enter the apartments of the sick as a part of their daily official inspection. This should not be permitted by the ship's surgeon, if cases of infectious diseases are present, unless there is some special reason for it. While there is practically no danger that these officers will transmit infection, through the medium of their clothing, they may themselves become infected, and thus extend the disease.

It will be appreciated that the care of cases of infectious disease at sea offers many obstacles, which do not present themselves on land. However, it should be always remembered that success in preventing or limiting the number of secondary cases depends on the proper isolation of those infected or suspected, and the

CLASSIFICATION

careful daily examination of all others on board.

If a case of infectious disease, particularly of the first class should appear during the voyage, the ship's surgeon must decide whether or not he shall notify the passengers and crew of its existence. If for instance the disease is smallpox, and there is a supply of reliable vaccine matter on board, as there should always be, the ship's surgeon is subject to just criticism if he does not promptly state the presence of the disease and urgently recommend vaccination. Whether or not he shall make known the presence of infectious disease in other instances must depend on the circumstances which present themselves, although concealment of the true condition is often followed by unpleasant results and is hardly in accord with modern sanitation.

CHAPTER III

MARINE SANITATION—QUARANTINE

THE term, marine sanitation, may properly be applied to the means taken at sea to insure cleanliness, to promote the physical well being, and to prevent outbreaks of infectious disease. The word “quarantine” indicates the means which are taken at sea-ports to protect against the invasion of imported infectious diseases. This word is of Italian derivation, and literally means a detention of forty days, and was first used in connection with measures taken in Venice in 1348 to guard against the introduction of plague, then on its way from the East. Quarantine stations were afterwards established along the Mediterranean coast, then in Europe, and subsequently throughout the world. It is probable, that when quarantine regulations were first instituted a detention of persons and vessels for forty days or thereabouts was actually enforced. Why this period was selected is not

MARINE SANITATION

clearly defined, although it was probably dictated by some theory regarding the period of incubation of disease, or the danger from clothing, cargoes of vessels, etc. While the quarantine regulations of this early period were exceedingly drastic, they offered but little protection, and it was not until definite scientific knowledge concerning infectious diseases and the means by which they are transmitted became available, that quarantine regulations offered real protection against the introduction of the infectious diseases from one seaport to another.

There are still numerous changes needed to bring this branch of the public health service in harmony with the dictates of modern sanitation, which demand that seaports shall be protected against imported diseases with the least annoyance and expense to the public and to commerce. The most important, practical and logical means of securing this result is greater vigilance at ports of departure in order that cases of infectious disease, or those who have been infected, shall not board outgoing vessels. This may be practically accomplished by detaining for a sufficient period under medical observation at the port of departure, those who

PREVENTION OF INFECTIOUS DISEASES

are about to sail, and who may have recently come from infected areas, and who may possibly be passing through the period of incubation of an infectious disease, and also by maintaining a strict watch over the crew while in port in order that they may not be subjected to exposure. To this should be added a careful daily examination of all on board during the transit of the vessel. If these preventive measures were carried out at ports of departure and during the voyage instead of relying on quarantine regulations at ports of destination for protection against imported infectious diseases, the serious delay and expense to the traveling public and commerce, which the latter methods now involve, would be greatly reduced, and quarantine would lose many of its objectionable features. This policy can be successfully carried out only by international agreement, and until the importance of it is fully appreciated and acted upon, there will continue to be many unpleasant quarantine measures enforced which are avoidable.

As a rule, quarantine stations deal only with diseases of the first class, although in some sections of the world infectious diseases of all kinds are brought under its direct or indirect

control. This occurs at the New York State Quarantine, where not only diseases of the first class are removed from incoming vessels, but also measles, scarlet-fever, diphtheria, and varicella. As diseases of the second and third class are commonly found in almost every community, and sometimes in large numbers without causing any apprehension or any special activity on the part of municipal health officials, it is questioned whether or not quarantine officers should take any action in the presence of these diseases beyond insisting upon their isolation on shipboard until they can be dealt with by the municipal authorities at the port of destination. However, those who have given this matter careful study know that the danger resulting from measles, scarlet-fever and diphtheria, and their complications are frequently very grave, particularly among immigrant children, who are of low vitality and are brought closely together on shipboard, and by exposure commonly contract two or even all of these diseases at about the same time, involving a very serious mortality. Therefore the removal of these cases at quarantine insures prompt care and treatment of the patient and better protection to the public.

PREVENTION OF INFECTIOUS DISEASES

Certain sections of the world are regarded as the home of some of the diseases of the first class; for instance, cholera and plague are almost continuously present in India, and yellow fever, until within a few years, was generally found in Cuba, Central and South America, Mexico, etc. It is a common belief that for some reason this condition is unavoidable and must continue to exist. Practical sanitarians know this is not true, and believe if modern sanitary regulations were strictly enforced, it would sooner or later result in the control or extermination of these diseases—of this evidence has already been presented as follows:

The commission appointed in 1900 by the President of the United States, and directed to proceed to Cuba to investigate and determine if possible the medium of infection in yellow fever afterward presented in their report conclusive evidence that this disease is transmitted only by a variety of the mosquito known as the “*stegomyia*.” This knowledge was subsequently used in Cuba as a basis for the employment of means for the extermination of both the disease and the mosquito, and as a result yellow fever has now practically disappeared from that country, where prior to the above in-

MARINE SANITATION

vestigations cases were almost continuously present in large numbers.

In India and other Eastern countries where infectious diseases of the first class are constantly present, there are almost insurmountable obstacles to their extermination or control because of the prevailing ignorance, poverty, overcrowding and religious fanaticism of the natives, and the fact that modern sanitary regulations are not in operation and for various reasons, political and otherwise, cannot be employed. It is the existence of these conditions that calls for the drastic quarantine regulations, which are maintained against these sections of the world by almost every civilized country.

Contrary to the general belief, the same character of quarantine regulations cannot properly be enforced at all ports, or in all sections of the same country, owing to the variations in climate, in shipping, etc., and the fact that certain infectious diseases propagate only in certain sections of the world; therefore, different regulations are required to conform to these several conditions. For instance, the "stegomyia," or yellow fever mosquito, breeds only in the southern sections of the United States, while the northern part is free from

PREVENTION OF INFECTIOUS DISEASES

it. Therefore in the latter part the same drastic regulations which are required in the South to guard against the appearance of this disease are not called for.

There is one condition, however, which should be uniform in all ports, and one which the public and commerce are justified in demanding, and that is that all quarantine stations shall be supplied with modern equipment, in order that the inspection and treatment of vessels and persons shall be thoroughly and promptly carried out.

To successfully direct the treatment of incoming vessels, passengers and crews, under all circumstances, it is important that a quarantine officer shall be practically familiar with infectious diseases under their various aspects as well as the means by which they are transmitted, and the methods which may best be employed to prevent their extension, for after a vessel has been released from quarantine, those on board pass beyond his jurisdiction and control, and so far as he is concerned may go to any section of the country they may select; whereas, in towns a suspect may be kept under official observation as long as it is deemed necessary. It is most important that a quaran-

MARINE SANITATION

tine officer should know the location of infected districts throughout the world, and the ports which act as outlets for these sections. It is also necessary for him to know what action has been taken at ports of departure in the way of detention and medical observation to prevent the introduction of infectious disease on shipboard. Reliable evidence in this direction oftentimes justifies a quarantine officer in dealing far more liberally with those on board than under other conditions.

Quarantine officers should always bear in mind that too much dependence must not be placed on official statements regarding the prevalence or nonprevalence of infectious disease at ports of departure or interior sections with which they are connected, as diseases often exist for sometime in a presumably noninfected area before the fact is officially known or admitted. However, as fairly accurate reports regarding the presence of the infectious diseases in foreign countries are found in the bills of health issued by the consular service in the various seaports throughout the world, they deserve careful consideration.

On boarding a vessel the quarantine officer should first request from the ship's surgeon,

PREVENTION OF INFECTIOUS DISEASES

if there be one on board, or if not from the captain, a full and complete medical history of the voyage, particularly if any deaths have taken place in transit, and if so, the cause, or if this is unknown the signs and symptoms which were presented during the illness of the patient. A minute description of any sickness that may have occurred among the passengers or crew during the voyage should also be obtained, and carefully considered, as the patient may have had a mild, ambulant, irregular or unrecognized attack of some infectious disease. Such cases not infrequently occur on shipboard and should be very carefully looked for. It is well to remember that masters of vessels are anxious to proceed to their destination, and dislike to be delayed at quarantine, and are therefore apt to forget minute details connected with the cases of those who have been ill on board. If there is any doubt about the accuracy of the statements which are made regarding this matter on vessels which carry no surgeon, a written medical report of the voyage should be insisted upon or an inspection of the log book should be made. Furthermore, a quarantine officer must not forget that statements made at quarantine by passengers and crews regard-

MARINE SANITATION

ing their ailments cannot be accepted in lieu of a careful examination. Not to appreciate this has led to many unpleasant and dangerous situations. A careful report made by the ship's surgeon regarding the medical history of the voyage is very valuable, because it may clear up some point regarding the conditions which have occurred on board which might otherwise be more or less obscure, and call for the enforcement of additional precautionary measures.

If a case of an infectious disease has occurred in transit, it is very necessary to know in what manner the patient has been isolated. It is also important to know what action has been taken in regard to the examination of suspects, disinfection, etc.

If the medical report is satisfactory the quarantine officer should proceed with the usual inspection of those on board.

The character of this examination depends largely on the sanitary conditions which exist at ports of departure, and in the interior sections of which the said ports are the outlets, and whether or not infectious diseases or suspicious cases have occurred during the voyage, the character of persons on board, the

PREVENTION OF INFECTIOUS DISEASES

length of time occupied by the voyage, etc. The examination may consist of a simple visual one as in the case of passengers and crews coming from noninfected sections, or it may include the use of the clinical thermometer or other special examinations in cases where extraordinary means are deemed necessary to detect the presence of infectious diseases, particularly of the mild or ambulant type, and in instances where vessels have come from infected areas.

In the examination of persons from infected ports, a quarantine officer is constantly dealing with periods of incubation, which constitute one of the principal factors in deciding the time of detention, etc. For instance, a vessel arrives from an infected port, and the time occupied in transit from the latter place exceeds the period of incubation of the disease in question; and if no cases of infectious disease nor a suspicious case have occurred among the passengers or crew during the voyage, and a careful examination shows they are well on arrival they cannot practically be regarded as a menace to the public health, and unless there is a special reason for it they should be subjected to no further detention. If, however, the period of incubation of the disease under consideration

MARINE SANITATION

has not expired on the arrival of the vessel at quarantine, at least some on board are subject to detention or to some other form of observation.

Practical experience has shown that with the probable exception of yellow fever, cabin passengers do not often transmit infectious disease from one port to another, the usual means of infection particularly on transatlantic steamships being the steerage or third-class passengers, as infectious diseases thrive principally in sections where ignorance, poverty, filth and overcrowding exist. Those who occupy cabin quarters do not often visit these places except for a short time and then guardedly so. Besides those who travel first class are usually responsible and solicitous regarding their health, and if they become ill on land or on shipboard promptly seek medical advice. For these reasons cabin passengers arriving on transatlantic steamships at the New York Quarantine Station are not inspected if the ship's surgeon reports that they are free from infectious disease, and that no case of this kind or a suspicious case has occurred among them in transit, and also if satisfactory evidence is presented that no outbreak of a disease of the

PREVENTION OF INFECTIOUS DISEASES

first class exists at the port of departure. However, if sickness is reported among the cabin passengers, a certificate of the ship's surgeon regarding the character of the ailment is never accepted in lieu of a careful personal examination on the part of the quarantine officer. The crews of these vessels are under like conditions also exempt from inspection. To attempt the examination at quarantine of the cabin passengers and crew of transatlantic vessels would under ordinary conditions involve an unjustifiable as well as a serious delay to commerce and to those who travel by sea.

Reasonable and practical quarantine regulations cannot insure complete protection against imported infectious disease, and attempts to obtain this result not only seriously injure commerce, but defeat the end in view. While there are many times, when the most stringent regulations are justified in dealing with incoming vessels, passengers and crew at quarantine, there is under ordinary conditions a limit in the enforcement of regulations beyond which a quarantine officer cannot go without being subject to deserved criticism.

Although third class or steerage passengers may embark at noninfected ports, there are

MARINE SANITATION

but few of them residents of these places. They commonly come from remote sections, particularly in the interior, where some form of infectious disease is frequently present, and where the existing sanitary conditions are unknown. These people, as a rule, live in the midst of poverty, filth and overcrowding, are ignorant, and have but little regard for their own health or that of others, and statements which they may make regarding their physical condition cannot be depended upon. Furthermore, they frequently arrive at a port of destination without a definite idea as to their future abode, and are apt to be at least temporary residents of lodging or tenement houses, the most favorable or likely places for outbreaks of infectious disease to occur. This class of passengers, therefore, should always be subjected to careful inspection on arrival at quarantine, no matter where they come from, and even if the port of departure is declared to be noninfected, and all on board are reported to be well and no sickness has occurred in transit.

While it is regarded as safe under ordinary conditions to exempt from examination cabin passengers and members of the crew arriving

PREVENTION OF INFECTIOUS DISEASES

on transatlantic steamships from noninfected ports, on arriving from sections of the world, particularly in the East, where infectious diseases of the first class almost constantly exist, they should always be subjected to careful inspection even if the ports of departure are declared to be free from outbreaks of these diseases.

Vessels without surgeons, which are long in transit and come either from reported infected or noninfected areas, should always be regarded with suspicion and all on board carefully examined. These vessels often carry as members of the crew natives of the East from whom practically no information regarding their physical condition can be secured, and disease among them can be detected only by the most searching examination.

If a visual examination is deemed sufficient it should be carried out on deck, if the weather permits, in order to secure all possible light, which is very essential, particularly when this form of examination alone is depended upon. Those to be inspected should pass one at a time in front of the quarantine officer with their heads uncovered. The latter is not called for as a mark of respect, but to secure a better ex-

MARINE SANITATION

amination of the face and forehead, which is important in identifying the eruption particularly in mild cases of smallpox, the disease of the first class which is most commonly dealt with throughout the world. Not only should the faces of the passengers and crews be carefully examined, but also the expression of the eyes, the gait, etc., as efforts are commonly made to deceive the inspecting officer by those who are sick. It is imperative that everyone subject to examination should be present or accounted for. For this reason a careful count should be made of those who pass in review, and this should tally with the number found on the ship's manifest. The method by which this important detail is carried out is immaterial, provided it is correctly and promptly done. At the New York Quarantine Station an automatic counter is used. This is a simple and accurate device manipulated by the hand. Preferably the count should be made by an assistant to the medical officer in order that the attention of the latter should not be interfered with during the inspection. If the first count is not exact, it must be repeated until all who are subject to inspection have been seen, for if some are missing and are not satisfactorily ac-

PREVENTION OF INFECTIOUS DISEASES

counted for, it is reasonable to assume that they may be sick and unable to report or are concealed about the vessel.

Whether a vessel comes from an infected or noninfected port, or whatever may be the character of the passengers and crew, every case of sickness on board should be personally and carefully examined by the quarantine officer. Failure to do this has many times been responsible for the introduction of infectious diseases into seaports. This should not reflect unpleasantly upon a ship's surgeon as he is not supposed to be an expert in the diagnosis of infectious diseases, while a quarantine officer should be an expert and practically familiar with these cases.

An examination of passengers and crew on an incoming vessel should not be attempted after sundown unless there is an abundance of artificial light, electricity preferred, otherwise many details of a person's appearance may be overlooked. It is always a safe rule to remove from an incoming foreign vessel any suspicious cases, the diagnosis of which cannot be positively determined and an infectious disease excluded, although the facts may not warrant the detention of others on board. There is one

MARINE SANITATION

condition, however, in which the presence of a suspicious case on shipboard always calls for extended and thorough action on the part of the quarantine officer. If a vessel arrives from a cholera-infected port, having on board a passenger or member of the crew suffering from some intestinal trouble or presenting some symptoms of this disease, although it may be neither typical nor very suspicious, the vessel should not be allowed to proceed, nor should anyone be allowed to leave or go on board the vessel until reasonable evidence is presented to exclude the presence of cholera. This should always include a bacteriological examination of the stools, or of a specimen taken from the rectum. The importance of this lies in the fact that in cholera infection may be distributed by discharges from the alimentary tract before active or serious symptoms of the disease appear. Bacteriology has become an exceedingly important factor in the diagnosis of infectious disease, and in the situation above referred to, it is not only justifiable, but a necessary procedure to detain a vessel until the bacteriological examination is made. This has been amply proven in dealing with vessels arriving at New York from cholera infected ports

PREVENTION OF INFECTIOUS DISEASES

during the recent outbreak of this disease in Europe. This also illustrates the imperative necessity of having a laboratory in connection with a quarantine establishment.

The detention of a vessel at quarantine for the isolation of those who are sick on board or for the observation of passengers and crew is not in compliance with modern sanitation, except in special instances. A vessel not only does not usually offer a proper or safe place for these purposes, but this procedure may involve a long delay and great expense to the owner of the vessel. Quarantine stations which do not have the necessary accommodations for the reception of the sick and for the detention of suspects are not properly equipped.

Persons held for observation at quarantine should be subjected to the most careful daily examination in order to detect the earliest appearance of secondary cases. In connection with this duty, it may be said that the thermometer is usually a valuable aid, and should be employed even where large numbers are under observation. Those detained at quarantine or on shipboard should so far as possible be divided into separate groups, particularly when they are indoors. This diminishes the

MARINE SANITATION

amount of exposure, and if secondary cases occur, the number held for further observation need not be as great, as when all are kept together. The measures which are to be taken in the treatment of persons held at quarantine will be referred to in detail in the special consideration of diseases of the first class.

Persons detained at quarantine are practically held against their will, and there is usually some antagonism or unpleasantness aroused; every effort therefore should be made to extend to them all possible attention and consideration, in order that their stay may be made as comfortable as possible. Unfortunately, this important detail is too frequently overlooked.

In describing the examination of passengers and crew on incoming vessels, the author has frequently referred to infected ports. To give an entirely clear and satisfactory definition to this term would be practically impossible. There are few if any cities or towns, which do not contain more or less cases of some of the infectious diseases, still they are not regarded as infected ports. The latter term is in a quarantine sense more restricted, and generally refers to the presence in a community of

PREVENTION OF INFECTIOUS DISEASES

cases of an infectious disease of the first class in sufficient numbers to materially involve the public health. If it is officially reported that a case of smallpox has appeared at a port of departure, a quarantine officer, although proceeding with great caution in the treatment of persons coming from that place, would not be justified in adopting such measures as would be appropriate if it were known that a formidable outbreak had taken place. Then again the character of the disease makes a difference in the practical interpretation of the term so far as a quarantine officer is concerned. In dealing with smallpox we have the means by which the disease can be prevented or controlled, i. e., vaccination. Chiefly for this reason outbreaks of smallpox are regarded as less formidable and not as much of a menace to the public health as some other diseases of the first class. On the other hand, if reasonable evidence is presented to show that cholera has appeared at a port of departure, or in a section where a port of departure acts as an outlet, even if only one case has been reported, a quarantine officer is justified in dealing with the place as an infected port at least until he is in possession of further information on the subject,

MARINE SANITATION

because cholera is rapidly transmitted through the medium of food and drink, and it is frequently difficult to trace the source of infection.

It is along these practical lines that a quarantine officer must act in dealing with outbreaks of infectious disease on shipboard.

CHAPTER IV

SMALLPOX

SMALLPOX does not always assume a typical form, and very mild cases frequently occur unaccompanied by marked constitutional symptoms; in fact, in some cases constitutional symptoms may be practically absent.

Smallpox is often mistaken for varicella or chickenpox, and sometimes for a noninfectious disease, because the general symptoms which usually accompany it, such as pain in the back, headache, elevation of temperature, etc., are either absent altogether or are not well marked.

The diagnosis of smallpox should always be based on the character and location of the eruption and not on the constitutional symptoms.—the latter are to be considered only after the eruption has been carefully studied. As smallpox is frequently confounded with chickenpox, it is essential that the differential diagnosis

SMALLPOX

between these two diseases should be familiar to sanitary officers.

In studying the eruption of smallpox and chickenpox, it is necessary to be familiar with the tissue changes, which take place in the skin in connection with the eruption of these diseases.

In smallpox the eruption appears first as circumscribed hyperæmic areas, the margins of which are sharply defined. The hyperæmia involves the true skin to a considerable depth and gives to the eruption in its early stages the sensation of shot placed just beneath the surface of the skin. Hence the term "shotty," which is so uniformly applied to the eruption of this disease. This tense hard condition naturally disappears as the papular and vesicular stages are succeeded by the pustular, or when suppuration occurs. As the true skin is deeply involved in the process, a permanent loss of tissue follows, the result of which is familiar to all as the "pitting" or disfiguration of smallpox. The depth to which the true skin is involved is not only responsible for the hard and resisting vesicles, which appear early in the disease, the top or surface of which can be removed only by considerable force, but

PREVENTION OF INFECTIOUS DISEASES

also for the comparatively slow manner in which the different stages of the eruption pass from one to the other.

The eruption in chickenpox is in marked contrast to the description just given. The vesicles are very superficial and do not as a rule involve the true skin; they practically consist of a circumscribed separation of the false from the true skin similar to the vesicles which appear in superficial burns. They contain either a transparent or pearly-hued fluid, are soft and pliable and can easily be detached—they are short-lived and end as vesicles, and soon become dried and form a superficial scab. It is of the greatest importance to bear in mind the superficial character and tenderness of the chickenpox vesicles. In order to practically illustrate this it is only necessary to sweep quickly and firmly the edge of the finger-nail over the vesicle, when the latter is easily torn apart. This does not occur in smallpox. Sometimes a chickenpox vesicle may become irritated, or for some other cause may affect the deeper structures of the skin. This accounts for an occasional scar, which may follow the eruption of the disease.

In smallpox the eruption passes through suc-

SMALLPOX

Eruption has
these successive
stages.

cessive stages as macules, papules, vesicles and pustules. In some parts of the body the formation of each stage, or the transition from one stage to another, may be a little more rapid, than in others; but when this is finished the eruption is complete and secondary crops never occur. Too much importance cannot be given to this peculiarity of the disease, as no other sign more closely approaches that of a pathogenic character.

The manner in which the eruption of chickenpox appears is diametrically opposite to that of smallpox, inasmuch as it notoriously comes in successive crops. Alongside of vesicles which have dried down with the formation of a black or dark scab, we find tender vesicles just appearing which are torn by a slight touch of the finger-nails. This is so strikingly apparent that it can hardly be overlooked even in a superficial examination. Moreover, the eruption of chickenpox appears abruptly as vesicles and ends as such. It may be added that the back presents probably the best surface to study the eruption of chickenpox.

In smallpox, even in mild cases, the face, hands and feet are practically always involved; while in chickenpox, even with a profuse eruption

hands
involved

PREVENTION OF INFECTIOUS DISEASES

tion on the face and body, the hands and feet have comparatively little eruption, although some vesicles are usually present in these places. The appearance of hard, tough, circumscribed and distended vesicles or papules on the hands or feet, particularly on the palms and soles, is an exceedingly important diagnostic sign of smallpox. Although the hands and feet are to a certain extent involved in the eruption of chickenpox, the palms and soles are not so often affected, although this may occur.

In regard to the umbilication, which in the older text books is spoken of as the pathogenic sign of smallpox, it may be said that while it is a well-marked, constant and valuable diagnostic sign of this disease, it may also be found in chickenpox, syphilitic eruptions, etc.

The course to be followed at quarantine when smallpox is found on an incoming vessel varies more or less in each instance. If the disease occurs on a freight vessel on which there is no surgeon, and where no special provision has been made for the sick in the way of hospital accommodation or quarters for isolation, the patient will usually be found in the fore-castle, or sometimes in an improvised hospital, where the quarantine restrictions imposed are of little

SMALLPOX

or no value, and it is reasonable to assume that there has been a general exposure of the officers and crew. This situation requires that all on board be subjected to some form of observation unless there is positive evidence that they have been successfully vaccinated just previous to the appearance of the disease. Great care must be used in the examination, as mild cases may pass unrecognized, for members of a crew do not usually respond to slight symptoms and often perform their regular duties on shipboard, even while they are sick, particularly when there is no ship's surgeon.

As a rule, the disinfection to be performed under the circumstances just referred to is confined to the patient's clothing, effects and contents of the apartment occupied by him.

When smallpox has occurred on shipboard, the officers may be allowed to proceed to the dock with the vessel, and there be subjected to a careful daily medical examination. These persons are responsible and usually can be depended upon to conform to the necessary restrictions, and as their detention at quarantine would seriously interfere with the movement and unloading of the vessel, it should not be enforced unless there is some specific reason for

PREVENTION OF INFECTIOUS DISEASES

so doing. The crew, however, cannot all be depended upon to remain on board or to present themselves at any given place for inspection, and for this reason certain ones must be dealt with in a different way—either by detention at quarantine, or by some arrangement which will insure their daily inspection during the period of incubation at some other place.

Smallpox found on an incoming passenger vessel requires more complicated action. As already stated in the previous chapter, infectious diseases of the first class, with the exception of yellow fever, do not often appear among cabin passengers. If, however, a case of smallpox is found among them on the arrival of the vessel at quarantine, the patient should be promptly removed and his clothing, effects and apartment be disinfected. No general disinfection of adjoining apartments, saloons, dining room, etc., is necessary. The other cabin passengers should not be held on shipboard or removed at quarantine for observation unless there is some special reason for so doing. These people are responsible, and many are concerned with important business and other interests which would seriously suffer if they were detained; besides, three or four hundred

SMALLPOX

cabin passengers are not infrequently found on shipboard, and an attempt to hold them at quarantine for a sufficient time to cover the period of incubation of the disease dating from last probable expose would be impracticable and unjustifiable. Persons who travel first class as a rule seek medical advice when they are ill, and infectious diseases occurring among them are promptly recognized. In some instances it may be deemed necessary to notify the health authorities at the home of these passengers of the exposure which has occurred, and request that they be kept under observation for the required period. It is proper that the members of the patient's family or his friends, or others who may have been directly exposed or in close contact with him, should be subjected to special observation. It is usually sufficient to warn cabin passengers among whom a case of smallpox has appeared to promptly consult a physician, if any symptoms occur during the succeeding two weeks. Fortunately, they generally do this without instruction as they fear the appearance of the disease. As a general measure of protection, they should be vaccinated before they are released from quarantine.

PREVENTION OF INFECTIOUS DISEASES

As there is but little communication on ship-board between the cabin and steerage passengers, there is no reason why in this instance the latter should be subjected to any detention or special observation if all are well on arrival; however, as a general measure of protection vaccination should always be recommended and insisted upon.

The treatment of the crew on vessels where smallpox has appeared among the passengers varies with each case, although the exposure is usually confined more particularly to the stewards or stewardesses, some of whom may have attended, or have been in close contact with the patient. Whether or not this group and others of the crew shall be removed at quarantine for observation, or left in charge of the ship's surgeon must be decided in each case by the quarantine officer, who must be guided in his decision by the protection which has been afforded by vaccination, by the position and living apartments occupied by the different members of the crew, by the willingness of the company or ship's surgeon to be responsible for the care of these suspects, etc. The stewards and stewardesses are, as a rule, permanently attached to the vessel, and if

SMALLPOX

proper care is observed may in some instances be left to the care of the ship's surgeon. Transatlantic passenger vessels remain in port but a few days, and the detention of permanent members of the crew makes it difficult for them to regain their vessel. In deciding what action must be taken it must be remembered, however, that the appearance of smallpox or any other infectious disease among the crew on the return trip of the vessel as a result of this condition is not to be desired. These emergencies indicate the great value of having a crew properly vaccinated on entering the service of the vessel, not only as a matter of general protection, but in diminishing the expense and delay to commerce in the way of detention, etc.

Smallpox occurring among steerage passengers at sea is frequently detected by the ship's surgeon in the early stage of the disease, and the patient is promptly removed to a special apartment or to the general hospital for isolation and treatment. If the case is found in the general hospital all others who occupy this apartment should be removed at quarantine for special observation, and the apartments and contents disinfected. As a

PREVENTION OF INFECTIOUS DISEASES

rule, the master of the vessel or the ship's surgeon has either thrown overboard or burned the patient's clothing, effects and bedding in the general apartment. If this has not been done and they still remain in this apartment, they should be promptly removed for disinfection or incineration. The mattresses used by steerage passengers are, as a rule, of but little value, and in these emergencies the master of the vessel frequently prefers to burn in the ship's furnaces all those found in the general apartment previously occupied by the patient rather than subject them to disinfection. Either way is desirable as a general sanitary measure, particularly as it is not always certain just what bed the patient may have occupied. In this instance it will be sufficient if the mattresses and other bed dressings are carefully opened and spread out, and subjected to sulphur dioxide which is to be used for general disinfection in the apartment by burning four pounds of sulphur to each 1,000 cubic feet. The disinfection of the clothing and effects of well persons occupying the same apartment with the patient is unnecessary.

The occurrence of smallpox among third-class or steerage passengers presents quite

SMALLPOX

another condition to deal with so far as the detention and observation of these people is concerned. The belief that principles should be followed in dealing with infectious diseases at quarantine rather than specific or printed rules and regulations is well illustrated in this instance. While cabin passengers who have been exposed to smallpox may properly be allowed to proceed to their homes for the reasons already given, steerage passengers should be subjected to some form of detention or observation. These people are generally poor and ignorant, often undecided as to their destination, and are indifferent about becoming a menace to the public health. Besides they are necessarily brought together in close and prolonged contact during the transit of the vessel, and are, therefore, more susceptible to infection; besides their time is as a rule of but little value to them. These conditions justify the removal at quarantine of at least all who occupy the same apartment with the patient, provided they have not been recently successfully vaccinated.

The appearance of smallpox in the steerage calls for no specific action on the part of the quarantine officer regarding the cabin pas-

PREVENTION OF INFECTIOUS DISEASES

sengers except to strongly recommend vaccination if this has not already been performed.

The action taken by the quarantine officer when smallpox has occurred among the crew depends on the protection afforded by recent vaccination, the degree of exposure, to what extent the crew can be kept under the jurisdiction of the ship's surgeon, etc., etc. The removal at quarantine of the entire crew of a large vessel, a transatlantic steamship, for instance, is a very serious matter, causing great delay and expense to the ship's owner and annoyance to those on board, and should be resorted to only as an extreme measure. Such a course is not, as a rule, justifiable on a large passenger vessel, particularly where the crew are divided in their work, and occupy separate sections of the ship, so that a general exposure is very unlikely.

Fourteen days is generally accepted as the maximum period of incubation in smallpox. Therefore, in the detention of passengers and crew at quarantine, or in the observation of persons on land who have been exposed to infection, this period dating from the last known exposure should elapse before the suspects are released.

In dealing with outbreaks of smallpox, either

SMALLPOX

on shipboard or on land, vaccination becomes a very important factor in limiting the extension of this disease. No one who is practically familiar with smallpox doubts the inestimable value of vaccination as a protection against this disease; its limitations, however, must not be overlooked. All agencies employed in the protection of the public health have some shortcomings, but this does not impair their usefulness or value. Smallpox does not always protect against a second appearance of the disease in the same person, neither does a successful vaccination always protect against smallpox. It is true that these exceptions do not occur frequently, and if this constituted the only uncertainty regarding vaccination its value as a protective agent would be better understood. The serious mistake made in placing absolute dependence on vaccination lies in the fact that the period of protection, which it affords against smallpox is not known, nor can it be depended upon. We do know that vaccination not only does not secure immunity for life, but that frequently this immunity lasts for a brief period only. An authentic case has been recorded in New York City, where smallpox occurred in a person who has been successfully

PREVENTION OF INFECTIOUS DISEASES

vaccinated nine months previously. For these reasons revaccination is advocated and insisted upon, but how long revaccination protects, or how often it should be performed is entirely theoretical, notwithstanding statements to the contrary. Unqualified statements made by public health officials that successful vaccination is an absolute protection against smallpox for a stated period frequently covering a number of years, furnish a strong argument for anti-vaccinationists, because they know that smallpox does occur in persons who have been successfully vaccinated and revaccinated. Persons who believe in vaccination will cite instances, where smallpox has appeared among members of their families or friends, who have been successfully vaccinated, perhaps recently, and they cannot reconcile this fact with the statements of public health officials already referred to. In this way the public confidence in vaccination is frequently diminished, and it becomes more difficult to carry out this important measure of protection.

It is believed by those who are practically familiar with vaccination, that if a person who has become infected with smallpox is successfully vaccinated within two or three days fol-

SMALLPOX

lowing infection the appearance of the disease will either be prevented, or will occur in a mild or modified form. The vaccination at quarantine of persons on incoming vessels who have been exposed to smallpox on shipboard a number of days before arrival is largely a matter of future safeguard, and should never be depended upon or accepted in lieu of detention or some form of observation for the period of fourteen days dating from the last exposure, particularly if the persons exposed are third class or steerage passengers or members of the crews. However, a recent successful vaccination performed before exposure to smallpox justifies the release of the person exposed. Scars of recent vaccination have a pinkish color; when they become white there is practically no method of detecting their age, or the degree of immunity which the vaccination has conferred; moreover, the statement of persons regarding the date of vaccination should never be depended upon unless a proper certificate to this effect can be presented.

When a case of smallpox appears on land or on shipboard, those who are in danger of exposure should be promptly vaccinated *without regard to previous vaccination*, unless this has

PREVENTION OF INFECTIOUS DISEASES

been very recently and successfully performed. This procedure involves practically no danger and offers so far as vaccination is concerned the most effective protection.

The value of vaccination is far more apparent when it is regularly performed, particularly among the employés of institutions, vessels, etc. The proper time to vaccinate those about to embark should be before the departure of the vessel. The United States Government urges that steerage passengers in transit to this country shall be vaccinated at the ports of departure or immediately after sailing, in order to afford better protection against outbreaks of smallpox which may occur on shipboard. While this is fairly well carried out, it cannot be depended upon, or rather the success of the operation cannot be depended upon. It is the rule at the New York Quarantine Station after the removal from the vessel to the detention station of steerage passengers who have been exposed to smallpox to promptly examine them, and to release all who show evidence of recent successful vaccination. This action could be taken on board, but the delay, etc., to the vessel involved in the examination, particularly where there are large numbers, would be more expen-

SMALLPOX

sive than the removal of the passengers at the quarantine station for inspection; besides, the majority of those who are removed have not been recently successfully vaccinated and are therefore held for observation.

The observation of those who have been exposed to smallpox should cover a period of fourteen days from the last exposure. This is not always easy to determine; therefore, the time of observation usually dates from the last known exposure. If a case of smallpox on shipboard has not been discovered by the surgeon or master of the vessel during the voyage, the period of observation must date from the arrival of the vessel at quarantine and the removal of the patient. If on the other hand the quarantine officer finds that the case was discovered before arrival at the port of destination, and is satisfied that during the intervening period the case has been carefully isolated, this period may be deducted from the fourteen days of observation or detention of those exposed. This, of course, does not apply to those who have been in attendance upon the case. The action to be taken, however, by the quarantine officer must depend upon the circumstances, which are presented in each instance.

PREVENTION OF INFECTIOUS DISEASES

In the performance of vaccination either on land or at sea, too much attention cannot be given to the selection and care of the vaccine virus. Carelessness in this direction too frequently occurs, and often renders absolutely valueless this method of protection. Furthermore, the scarification and the careful rubbing in of the vaccine matter is also exceedingly important. Various methods are employed for this purpose, and in some countries more than one scarification is made at each vaccination. There is no proof, however, that this secures better immunity provided vaccination is properly performed. The Department of Health of New York City some years ago introduced a method of vaccination which apparently yields the best result obtainable. This consists in the scarification of the skin with an ordinary needle, the skin being made a little tense. A space about the size of the small finger-nail is scratched with the point of the needle, the scarifications being at right angles with each other. This, if lightly and properly done, does not cause too much blood to flow, which is undesirable. The liquid vaccine matter is then rubbed well in the scarifications with a clean and fresh wooden toothpick; in each instance

SMALLPOX

the needle and toothpick used are thrown away and fresh ones used for each person vaccinated—a very important consideration.

The method of preparing vaccine virus employed by the Department of Health of the City of New York illustrates the modern and proper means of procuring this protective agent. It consists of a glycerine emulsion of the pulp curetted from vaccine vesicles produced on animals. Healthy animals, usually calves, are chosen, carefully cleaned and shaved over the posterior surface of the abdomen and the inner surface of the thighs. At this site linear incisions are made into which are rubbed seed virus. Calves are selected largely for economic reasons. Rabbits are used in some laboratories. The seed virus usually consists of specially chosen vaccine virus collected from other animals dried or preserved in glycerine in cold storage. Sometimes the seed virus is taken from rabbits and sometimes from children. Usually on the fifth or sixth day after the inoculation of the calves, the linear incisions show confluent vesicles. The vaccination area is then carefully washed, and the vesicles scraped from the skin with a curette. The material so collected is weighed and mixed by some

PREVENTION OF INFECTIOUS DISEASES

form of grinding machine with a measured amount of glycerine and water. To one part of the pulp is added an amount of the diluent, which varies from four to eight parts. The diluent is composed usually of glycerine and water, about 50 per cent of each. In some laboratories an antiseptic is used. The creamy emulsion is put up in sealed capillary tubes and in vials. Before being issued the virus is examined bacteriologically for the presence of contaminating organisms. It is also injected into animals to discover any pathogenic effect and is further used in direct vaccination to test its efficiency. Special anærobic tests are regularly made to detect the presence of tetanus germs. Virus so prepared is expected after a short period to be practically free from bacterial contamination; to be so efficient that it will produce a vaccine vesicle when inoculated on a previously unvaccinated person in nearly 100% of cases, and to maintain such efficiency for at least three months from the date of collection.

CHAPTER V

YELLOW FEVER

IN 1900, a medical commission was appointed by the President of the United States and directed to proceed to Cuba to discover, if possible, the cause of yellow fever, and the means by which it is transmitted. The report of this commission presented indisputable evidence that this disease is transmitted by a variety of the mosquito known as the "*stegomyia fasciata*." The value of this discovery cannot be overestimated, as the knowledge thus gained furnishes means by which outbreaks of yellow fever may be prevented or brought under prompt control. Furthermore, it makes disinfection in connection with yellow fever unnecessary; this alone extends to commerce and those who travel by sea relief from certain quarantine regulations, which in the past have caused great annoyance, delay and expense.

The manner of dealing with persons who ar-

PREVENTION OF INFECTIOUS DISEASES

rive at quarantine from yellow fever infected areas depends largely on the time taken in transit, the conditions which are presented on reaching quarantine, and whether or not the port of destination is within the yellow fever zone, etc. If the voyage has occupied five days or more, and all on board are found to be well on arrival, with normal temperatures, the vessel, passengers and crew should be promptly released without further treatment. If any are found to have a temperature above the normal register, which cannot be clearly and definitely explained as the result of some non-infectious condition, or if any are indisposed, they should be detained for observation unless they present official or other proof of immunity from yellow fever; however, evidence of this should be accepted with great caution. In connection with this disease it may be repeated that it is very unsafe to accept from passengers or crew who may have been exposed to infection statements which are intended to explain an elevation of their temperature.

If the time consumed by the voyage is less than five days, all on board who do not present satisfactory evidence of immunity from yellow fever should be held for observation until the

YELLOW FEVER

expiration of five days dating from the time of departure from the infected area and then released only after their temperatures have been taken and they are found to be well.

In the examination of passengers and crews from yellow fever districts, it is very important to remember that while five days represents the usual period of incubation, it may extend beyond this time. However, within five days there is almost always some evidence of the disease, which can be detected by a careful inspection; a visual examination is frequently not sufficient to detect a variation from the normal condition; for this reason the use of the thermometer should constitute an essential part of the examination. In this way the invasion of the disease, and also the presence of mild cases are discovered—the latter frequently occur and often pass unrecognized, and are responsible for outbreaks of the disease, which are attributed to other source of infection.

If yellow fever is found on an incoming vessel, which has been five days or more in transit, and arrives at a port definitely known not to be in the yellow fever zone, it is only necessary to remove for treatment or observation the yellow fever patient and others who are ill, or who may

PREVENTION OF INFECTIOUS DISEASES

have elevated temperatures. Under these circumstances there is no logical reason why the patient with this disease should not be placed in a general hospital for treatment, as the medium of infection, the stegomyia, is not present. This custom, however, is not usually followed.

If a case of yellow fever is found on a vessel arriving at a port within the yellow fever zone, or where the "stegomyia" propagates, the situation represents an entirely different and more serious aspect. In this instance the case must be removed as promptly as possible at quarantine, and placed in an apartment securely protected by netting, etc., in order to prevent the entrance and exit of insects. So far as the passengers and crew are concerned, it is the author's belief that if more than five days have elapsed since leaving the infected port it would be safe to allow them to proceed if they are found to be well and their temperatures are normal, and provided it can be proven that the patient was infected at the port of departure. However, it is the usual quarantine regulation in the yellow fever zone to detain for five days after arrival from a yellow fever infected port all who do not present evidence of immunity, and then treat the vessel with

YELLOW FEVER

sulphur dioxide or some other agent for the purpose of destroying the mosquitoes which it is presumed may be on the vessel.

The question is frequently asked if the "stegomyia" or yellow fever mosquito is not found, or does not propagate, in New York City, and yellow fever, therefore, cannot extend, why are precautions taken to prevent the entrance of yellow fever into that place. The reason is that these regulations are not enforced to protect the immediate section about the port of entry, but remote areas in the yellow fever zone. If a vessel arrives at New York before the expiration of five days after leaving an infected port, and no detention of passengers or crew is required to complete the period of incubation, a case of yellow fever, particularly in a mild, ambulant or unrecognized form, or a person passing through the stage of invasion of the disease could land and proceed during the period of incubation to a point within the yellow fever area, and there cause an outbreak of this disease.

The possibility of infected mosquitoes being on shipboard presents one of the most debated and, so far as commerce is concerned, one of the most important questions connected with

PREVENTION OF INFECTIOUS DISEASES

the treatment of vessels and persons arriving from districts infected with yellow fever.

Careful investigation shows that outbreaks of yellow fever on shipboard may almost invariably be traced to infection received at the port of departure and not on the vessel, and that contrary to a general belief infected mosquitoes are of rare occurrence on shipboard.

Whatever difference of opinion may exist among sanitarians regarding this point, it is certain that it has received but little practical and scientific consideration, and that the greater part of the data, which have been presented as proof that infected mosquitoes are often present on shipboard cannot be accepted as reliable.

The port of New York probably receives one-half or more of all foreign vessels coming to the United States. A large number of these are constantly arriving from yellow fever ports; consequently the records presented by the New York Quarantine Station regarding the presence of infected mosquitoes on shipboard must be accepted as valuable evidence in this direction. As the "stegomyia" is not found in this section of the United States, yellow fever does not propagate here. This fact

YELLOW FEVER

should therefore more clearly serve to identify the origin of a case of this disease appearing in New York City than in a community within the yellow fever zone, where the disease oftentimes propagates unknown to the health authorities.

An authentic history of the various outbreaks of yellow fever occurring in New York, between 1793 and 1822, a copy of which is in possession of the author, presents satisfactory evidence that the disease during this period was introduced by sailing vessels arriving principally from Cuban ports. It is clearly shown that these outbreaks were connected with the arrival of vessels frequently having on board cases of illness, presumably yellow fever, or reporting that one or more members of the crew had died of this disease, while in Cuban, other West Indian or southern ports, or during a long and tedious voyage. The subsequent appearance of yellow fever in New York among the residents of houses situated along the waterfront in the immediate vicinity of the wharves, where these vessels were docked, indicates that vessels coming from infected ports not only brought cases of this disease, but also carried infected and non-infected mosquitoes and their

PREVENTION OF INFECTIOUS DISEASES

breeding places as well. The official reports constantly refer to the perishable, decomposed and offensive cargoes, and also the offensive bilge water found on these vessels. This material undoubtedly contained the *stegomyia* larvæ and was usually thrown overboard or pumped out at the wharf on arrival in New York. The larvæ developed into winged-insects and transmitted to others the disease already introduced.

In Dr. Townsend's official report of the outbreak of yellow fever in New York in 1820, he says: "We have direct and positive proof that two of these vessels, at least those in which several of the crew died, contained the poison in all of its virulence."

The severity of some of the outbreaks of yellow fever in New York and Philadelphia is shown by the mortality which occurred. The following data are derived from a report made by Dr. Harris in 1798:

	Year.	Deaths.
Philadelphia	1793	4041
New York	1795	732
New York	1798	2086
Philadelphia	1798	3506

And also from a subsequent report made by Dr. Townsend as follows:

New York	1803	606
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YELLOW FEVER

After 1803, and until 1856, outbreaks of diminishing severity occurred quite frequently in New York, Philadelphia and other ports of this section of the United States, and then none again until 1870, when a very limited outbreak appeared in New York. Since the latter period (1870), forty years ago, there have been no outbreaks of yellow fever in New York, or in its vicinity, although persons who have been infected in other ports have developed the disease here. The striking significance of this lies in the fact that this change, i. e., the disappearance of outbreaks of yellow fever in this section has taken place in the face of an enormous increase in the commerce between New York and yellow fever ports.

In studying this subject, we must bear in mind that the "stegomyia," or yellow fever mosquito, for some reason is not found in certain sections of the United States, although the outbreaks in New York already referred to furnish proof that if the "stegomyia" is brought here during the summer either as the winged-insect or larva, its propagation during the warm weather would follow. There is, however, no reason to believe that the insect is perpetuated in this section by hibernation during the winter

PREVENTION OF INFECTIOUS DISEASES

months, either in the form of the egg, larva, or winged-insect, but disappears in the fall and reappears only in the form of a fresh importation.

There can be no doubt that in the early period referred to and under exceedingly bad sanitary conditions, both breeding places and infected and noninfected "stegomyia" were frequently present on shipboard. There is equally good reason to believe that the danger from this has gradually disappeared and that the presence of infected mosquitoes on shipboard is now a rare occurrence. The author believes that the explanation of this change is as follows:

The commerce between this country and foreign ports was formerly carried on by sailing vessels, which usually remained in port for a long period in order to secure a full cargo. Their sanitary condition was unusually bad, their cargoes frequently consisted of perishable material, the holds of the vessel contained more or less water, which furnished breeding and feeding places for the mosquito. The residential portions of Cuban as well as other seaport towns in earlier times were commonly along the water front; therefore a vessel and its crew became practically a part of the com-

YELLOW FEVER

munity while in these places, and it is reasonable to suppose that breeding places and also infected mosquitoes should have been found on these vessels, and, if yellow fever existed, there was no reason why members of the ship's crew should not easily have contracted it, and subsequently transmitted it to others on shore or on shipboard. There can be no doubt that these vessels on their arrival at New York after a long voyage frequently brought with them persons suffering from yellow fever, infected mosquitoes, and also breeding places for the mosquito, and it is not difficult to understand why people living along the water front in the vicinity of the docks, where these vessels were moored and discharged, should have been infected, since cases of yellow fever and infected and noninfected mosquitoes and their larvæ were transferred to the shore from the vessel.

It is very significant that outbreaks of yellow fever in New York, Philadelphia and other ports in this section of the United States practically disappeared when a radical change took place in the character of the vessels engaged in commerce. Sailing vessels were replaced by steamers, which make quick voyages and are

PREVENTION OF INFECTIOUS DISEASES

kept in comparatively good sanitary condition and afford but little or no opportunity for mosquito breeding on board. In late years, as the result of the great increase in commerce, the water fronts in many of the yellow fever ports have been appropriated by docks, storehouses, etc., and the residential portions of these places have been transferred to the interior. As the "stegomyia" notoriously remains in close proximity to its home, it is reasonable to suppose that the mosquitoes which are found on board vessels lying at the dock are not often from infected sections; again, great advances have been made in the enforcement of sanitary regulations for the protection of the public health in these ports, which in many ways tend to make the presence of infected mosquitoes on shipboard a rare occurrence.

Occasionally an account is given of the development of one or more cases of yellow fever, believed to be due to the presence of infected mosquitoes on shipboard. No one who has given this subject careful consideration believes this to be impossible, or that it may not occur; but, the frequency with which it occurs is a disputed point. Cases believed to be yellow fever caused by infected mosquitoes on ship-

YELLOW FEVER

board, are occasionally reported on the arrival of vessels at the New York Quarantine Station. Thus far in every instance either the clinical evidence, or a blood examination have shown them to be malaria, or some disease other than yellow fever. It is noticeable that since blood examinations have been made to determine the presence of malaria, reports of secondary cases of yellow fever, believed to be due to the presence of infected mosquitoes on shipboard, are not often reported.

Many vessels arrive at New York from Cuban, South American and other ports, where more or less yellow fever is or has been almost continually present, but not a case of this disease has been removed at the New York Quarantine Station from an incoming vessel, at least during the past fifteen years, the infection of which could not be traced to the port of departure. Yellow fever until recently has almost constantly existed in Rio de Janeiro and Santos, Brazil, in an epidemic form, but no case of this disease has reached New York on any of the vessels frequently arriving from these ports, although evidence has been presented by the captain or ship's surgeon, that within three or four days after leaving the above named ports,

PREVENTION OF INFECTIOUS DISEASES

cases appeared, which from the history submitted were evidently yellow fever. These almost always proved fatal after the lapse of three or four days, but in no instance has a case of yellow fever reached the New York Quarantine Station from the section just referred to. It may be stated that these vessels are about three weeks in transit, which is a sufficient time for the yellow fever organism to develop in the bodies of any mosquitoes, which may be present and transmit the disease to those on board. Vessels from these ports have often arrived with suspicious cases on board, but careful investigation has proven that they were not yellow fever. Does it not appear strange that if yellow fever not infrequently occurs on shipboard as the result of the presence of infected mosquitoes some evidence of this would not be presented at the port of New York? Furthermore, evidence that infected mosquitoes are rarely found on shipboard is presented by the fact, that vessels are almost daily arriving at New York from Havana, and other Cuban ports, which in the past have frequently brought cases of yellow fever to New York, but in no instance has it been shown that this disease subsequently ap-

YELLOW FEVER

peared among those who were fellow passengers, or among members of the crew of these vessels; and in all cases of yellow fever removed at the New York Quarantine Station it has been shown that the disease appeared within five days after leaving the infected port. If infected mosquitoes invade vessels, why has not some evidence been presented at New York to indicate their presence? The passengers on these vessels are largely New Yorkers, or residents of other sections where yellow fever does not propagate and the crews are more or less permanent and under close observation. Therefore, if yellow fever subsequently occurred as the result of infection on shipboard, it is reasonably certain that it would be known.

It is believed by some that infected mosquitoes may be concealed in the cargoes of vessels, particularly those carrying bananas, and that by this means yellow fever has been introduced into seaports. It has been suggested that outbreaks in New Orleans and Havana have occurred in this way. Vessels are frequently arriving at New York from Central American and other ports with cargoes of bananas and other fruit, etc., but no evidence

PREVENTION OF INFECTIOUS DISEASES

has been presented to show that those who have unloaded these cargoes, or have had to do with the vessels while here, have contracted yellow fever. As has already been stated, evidence presented at the port of New York is of more value in deciding this question than evidence presented at New Orleans. The appearance of yellow fever among men employed in New York to unload a fruit vessel from an infected port would afford reasonable evidence that the disease was contracted from infected mosquitoes on shipboard, inasmuch as yellow fever does not propagate in New York, and there would be reason to believe that there was no other way of contracting it providing the patient had not been out of the city. On the other hand, a person in New Orleans employed in unloading fruit vessels might probably be exposed to other means of contracting the disease, inasmuch as New Orleans is in the so-called yellow fever belt, and it has been shown that the disease has frequently existed for some time in different sections of that belt unknown to the authorities.

The author has made a careful and thorough investigation as to the danger from infected mosquitoes in baggage, packages, etc. Boxes,

YELLOW FEVER

canvas bags and other receptacles were filled with clothing, bedding, etc.; mosquitoes were introduced, which were secured with great care from horses taken to mosquito-infested districts for this purpose. The mosquitoes were captured while on the horses by placing glass test tubes over the insects, and preventing their escape by closing the mouths of the tubes with light cotton plugs. These tubes were very soon afterwards introduced into the packages referred to and carefully withdrawn in order to release the mosquitoes without injury—at least, less injury to them occurred in this way than would follow their imprisonment during the process of packing. An accurate account was kept of the number of mosquitoes in each package, and although many of these tests were made covering a period of three or four months, it was found that in no instance did the mosquito survive after a confinement of thirty hours. It may be stated that the mosquitoes used in this test were the “*Culex sollicitans*,” or Atlantic coast mosquito, a hardy variety of this insect. Careful investigation has also shown that while mosquitoes may be found on vessels at the dock, and within a day or two after departure, they afterwards disap-

PREVENTION OF INFECTIOUS DISEASES

pear, and it is fair to assume that they are very early lost at sea.

If infected mosquitoes reach vessels lying at yellow fever ports and constitute a menace to those on board, and at the port of destination, is it not imperative that efforts should be made to destroy them at the time of departure or promptly afterward instead of at the port of destination, and thus avoid the danger of infection during the voyage? Furthermore if this treatment is necessary how is it to be determined in which apartment on shipboard the presumably infected mosquitoes are concealed? If this cannot be ascertained, is it then not necessary that every apartment should be similarly treated and as near as possible at the same time? This method of treatment, however, is not and cannot be carried out, as sulphur dioxide, which is usually employed to destroy mosquitoes, is incompatible with respiration in the human being. Moreover, in a large steamship containing first, second and third cabin accommodations, fore-castle for crew, holds, etc., the apartments are so numerous and so freely open into the outside air, that to properly seal them and carry out the treatment referred to would entail much expense and long delay. It would

YELLOW FEVER

cripple commerce fully as much if not more than the methods of disinfection formerly employed. In the engine room, for instance, which would probably be an abiding place for the mosquito, this treatment would necessitate a serious interference with the working of the machinery, as the men employed in this section of the ship would be obliged to leave their posts during the use of the sulphur dioxide.

It has been recommended that sulphur dioxide be introduced into the hold of the vessel before the cargo is removed in order to destroy the mosquitoes, which may be present there. Those who are practically familiar with the treatment of vessels know that this cannot be depended upon, and that neither the cargo or hold of a vessel can be properly treated or disinfected until after the former is removed, notwithstanding statements to the contrary.

If this subject is considered from a practical standpoint, it will be better appreciated that the treatment of a vessel to insure destruction of mosquitoes, which are presumed to be on board is an exceedingly formidable and expensive undertaking, involving a long delay to commerce and the traveling public, and should

PREVENTION OF INFECTIOUS DISEASES

be required only when there is satisfactory proof that it is necessary. The theory that infected mosquitoes are concealed in vessels and their cargoes and thereby constitute a menace to the public health derives its support largely from the fact that outbreaks of yellow fever, the origin of which is unknown, have not infrequently appeared in southern seaports. In these instances the theory above referred to offers an easy explanation of the presence of the disease. As a matter of fact such outbreaks are usually due to mild, ambulant or unrecognized cases and the methods which have been employed in the past for the examination of those arriving from yellow fever infected ports have not been sufficiently thorough to detect their presence. Each year furnishes additional evidence of the truth of this statement. It must be borne in mind that the signs and symptoms of this disease do not always present themselves prior to the fifth day. During the summer of 1905, a number of cases of yellow fever arriving on vessels from Colon were removed at the New York Quarantine Station. These vessels are usually seven days in transit. Three of the cases removed presented themselves at the inspection of the vessel on its arrival, stated

YELLOW FEVER

that they were well, and had not been sick during the voyage. This statement was partly confirmed in one instance by the fact that the patient had appeared at the breakfast table. However, when the thermometer was used, it was found that their temperatures were considerably above the normal register and they were removed to quarantine for observation. Two of the cases died within four days afterward at Swinburne Island Hospital. After reaching the latter place, they frankly admitted that they had not been feeling well for two or three days. Cases of this character cannot be regarded as uncommon. The fact that the disease may not be apparent or may be concealed until the seventh or eighth day undoubtedly has given rise to the belief that infection may have been communicated on shipboard.

The more familiar we become with the infectious diseases and their character, the more we appreciate the fact that they frequently appear in a very mild, or unrecognizable form, and that the accepted maximum period of incubation is often exceeded. Not to understand this has given support to various erroneous theories regarding the transmission of disease.

No well-informed sanitarian doubts that it

PREVENTION OF INFECTIOUS DISEASES

may be possible for infected mosquitoes to exist on shipboard, and it is likely that some of the statements presented in proof of this are authentic, but it occurs so rarely that quarantine officers are not justified in crippling commerce and causing the detention of persons by attempts to destroy possibly infected mosquitoes on vessels arriving from yellow fever infected ports, unless in each instance there is at least reasonable evidence that the mosquitoes are present. Then great care should be taken to treat so far as possible all portions of the vessel with sulphur dioxide in a proper and not a perfunctory way. It may be said that at the present time this agent is the only one known, which can be depended upon for this purpose. One pound of sulphur should be burned for each 1000 cu. ft. of space with an exposure of two or three hours. This amount is ample to destroy all mosquitoes with which it may come in contact.

CHAPTER VI

TYPHUS FEVER

TYPHUS fever spreads with great rapidity where overcrowding and poverty exist, and when it occurs in a community it is almost always confined to sections occupied by the lower classes. In earlier times it frequently appeared on shipboard, and in public institutions, and was variously known as "ship" fever, "jail" fever, etc. It must be understood, however, that in instances of this kind infection is introduced from outside although the bad sanitary conditions such as overcrowding, imperfect ventilation, etc., which in former times frequently existed on sailing ships, in jails and other public institutions are chiefly responsible for the rapid dissemination of the disease.

A large per cent of those exposed to small-pox are either already protected by vaccination, or can promptly secure its benefits, and individual and general protection against this

PREVENTION OF INFECTIOUS DISEASES

disease are thus afforded. In yellow fever means are also at our command by which infection can almost always be prevented or outbreaks quickly brought under control. In a measure this may be said of plague, but in typhus fever no such protection can be secured. Therefore the most stringent regulation must be enforced in dealing with outbreaks of this disease.

The invasion of typhus fever is abrupt, and a careful examination will generally detect it in its early stages. The comparatively high temperature, which occurs at the outset, the early involvement of the mental faculties, and the suffused conditions of the eyes, and cyanosed appearance of the skin, coupled with a maculo-petechial eruption, which does not disappear on pressure, and which appears within two or three days after the invasion can hardly be overlooked by a careful observer. However, the disease is not infrequently mistaken for pneumonia, typhoid fever, etc., particularly at the beginning of an outbreak and before the existence of the disease is suspected or recognized. While this in a way may be excusable on land, a ship's surgeon or quarantine officer should never have out of his mind the possibility of diseases of the first class occurring on

TYPHUS FEVER

shipboard, and the fact that they may appear in a mild or not easily recognizable form.

When, for instance, typhus fever occurs on a transatlantic passenger vessel it is almost always found among the third class or steerage passengers, who frequently come from infected centers. The period of incubation may expire shortly after the vessel is at sea, and the symptoms have become so well marked on arrival at the port of destination, that it is not usually difficult to recognize the disease. A more serious condition arises when a person who has been infected shortly before embarkation reaches the port of destination before the period of incubation expires, presents no evidence of the disease and may land and reach an interior town before the invasion occurs. To completely guard against this danger at a port of destination, it would require the detention for a number of days of all passengers and crews who arrive from infected ports or interior sections even if all are well on arrival. This procedure would involve great delay and expense to commerce particularly where large numbers are concerned and could not except in some special instance be regarded as practicable or justifiable. The most effective and practical

PREVENTION OF INFECTIOUS DISEASES

method of preventing outbreaks of typhus fever or any other infectious disease at sea has already been described, i.e., the detention under medical observation at the port of departure of at least all persons arriving from presumably infected centers.

As a matter of special precaution against typhus fever as well as other infectious diseases, even on vessels which come from alleged noninfected ports, there should always be a careful daily inspection of all steerage passengers and all cases of illness should be promptly removed to the hospital for observation without waiting until a definite diagnosis is made. The great value of this course lies in the fact that it secures early isolation, a most important factor in the protection of those on the same vessel. If the patient has not been isolated and is found by the quarantine officer in the general apartment with other steerage passengers, there is every reason to expect that many cases will follow. The serious character of typhus fever, the rapidity with which it travels among certain classes, and the fact that steerage passengers on arriving at a port of destination immediately become a part of the tenement and lodging house population of the large cities,

TYPHUS FEVER

and if infected freely transmit typhus fever to those about them, call for the enforcement of the most thorough regulations to guard against the extension of this disease. Steerage passengers among whom typhus fever has appeared during the voyage should always be held for observation on arrival at quarantine. As members of the crew particularly the stewards and stewardesses are always more or less in contact with the steerage passengers, they should also be subjected to detention or at least some form of observation, for they are not as a rule responsible and cannot be depended upon to comply with sanitary regulations after their release. Many of them are temporary employés only, and when on shore frequent cheap boarding and lodging houses and do not promptly seek medical advice, when they become ill and are potent factors in transmitting infectious diseases. As the officers of the vessel are very essential to the care of the vessel, it may be deemed safe by the quarantine officer to allow them and possibly some members of the crew, who may be depended upon to remain on the vessel under daily observation.

In dealing with typhus fever occurring in the steerage, great caution should be observed in

PREVENTION OF INFECTIOUS DISEASES

the release of second cabin passengers who occupy a position between saloon and steerage passengers, and who on some vessels often affiliate with the latter. For this reason they are not always entitled to the same consideration that may be extended to saloon passengers, and their detention, or careful observation under certain conditions, is far safer to the public than their release. A quarantine officer, however, is justified in dealing liberally with saloon or first cabin passengers who are practically separated from the other classes on board as they are usually responsible, besides, typhus fever rarely extends among this class. However, it may be advisable to notify the health authorities at their home of their possible exposure. For these same reasons the appearance of typhus fever among the first cabin passengers would not necessarily involve the detention of the second and third class passengers and crew except in those instances where there has been evidence of direct exposure particularly among the stewards and stewardesses.

As an aid to the quarantine officer in deciding these questions, it may be again stated that typhus fever does not often appear among persons in the better walks of life, nor does the

TYPHUS FEVER

disease commonly affect physicians, who are attending typhus fever, but rather the nurses who are in more or less close and prolonged contact with the patient. This shows that considerable exposure is usually required to contract this disease where good sanitary conditions are present. Members of the patient's family, his friends and attendants who have been in close contact with him always constitute a dangerous group of suspects and should be placed under special observation.

The occurrence of typhus fever on a freight vessel or even on a small passenger ship, where both passengers and crew are commonly brought together should as a rule involve the detention or the observation in some form of all on board.

The disinfection performed on a vessel on which typhus has occurred should be practically the same as when smallpox has occurred. The apartment or hospital where the patient is isolated, and its contents, as well as the bedding and effects of the patient in the general apartment occupied by him previous to his removal to the hospital should be subjected to special disinfection. The remainder of the bedding, in the general apartment should be

PREVENTION OF INFECTIOUS DISEASES

spread out and fully exposed to sulphur dioxide properly generated in the apartment. The clothing of those who have occupied the same general apartment with the patient need not be subjected to disinfection.

The period of incubation of typhus fever generally ranges from eight to twelve days; therefore, those held for observation should not be released until the expiration of the latter period, and then only if they are well and their temperatures are normal.

If during the period of detention typhus fever should appear among any one group under observation the remainder of this group should be held for further observation, although this extra detention need not involve other groups if they have been properly separated. This however is a detail, which must also be decided in each instance by the quarantine officer. In the consideration of this question the great importance of the careful segregation of those held for observation is apparent.

CHAPTER VII

CHOLERA

THE appearance of cholera either on shipboard or on land calls for greater care in the isolation of those sick with the disease, the detection of the medium of infection, the disinfection of the excreta and the effects of the patients and the treatment of those under observation than in the case of any other infectious disease. The source of infection where serious outbreaks occur is usually a common one, and under these circumstances the disease is apt to spread with great rapidity. Fortunately, however, in communities where proper sanitary conditions exist and on modern passenger steamships there is practically but little danger of a general cholera infection, due to an infected water supply. Those living in a community where cholera exists may escape infection by observing certain simple precautions relating to food and drink, cleanliness, etc.

PREVENTION OF INFECTIOUS DISEASES

Cholera is not contracted in the same manner as smallpox, measles, etc., but through the mouth, by infected food or drink containing the specific organisms of the disease, or by the hands, or articles contaminated by discharges from the intestinal tract of those who are carriers of this organism.

Upon the appearance of cholera the most extended and exhaustive investigation should be made to discover the medium of infection; this course is imperative and unless it is carefully followed out the outbreak will not be successfully controlled. The influence of the fomites theory regarding the means of infection is still apparent in connection with this disease, and clothing, baggage, letters, etc., are frequently referred to as media of infection. There is no practical or scientific support for this belief if clothing directly contaminated with intestinal discharges is excluded. The acceptance of this theory may very seriously interfere with an early detection of the real cause of the outbreak.

The danger of the introduction of cholera from one port to another is not so much by typical cases (which are usually easily detected), as the mild or irregular ones, which

CHOLERA

often pass unrecognized. Cholera may appear in the form of a simple diarrhoea, which excites little or no suspicion, or it may appear in a more obscure manner, and simulate some other affection. Furthermore, cholera is not infrequently transmitted from one place to another by well persons known as carriers, who may act as a medium of infection without presenting any symptoms of the disease. This has an exceedingly important bearing in the consideration of the means by which this disease is transmitted.

While certain articles of food or drink brought from an infected district may contain the specific organism of cholera and may subsequently act as media of infection, there is reason to believe that this is not of very frequent occurrence.

All vessels arriving from cholera infected or suspected districts having on board even mild cases of diarrhoea, or those who are ill with an affection, the diagnosis of which cannot be clearly defined or in which cholera cannot be excluded, should be held until a specimen from the rectum or some intestinal discharge is obtained and subjected to a bacteriological examination. Neither the vessel, passengers nor

PREVENTION OF INFECTIOUS DISEASES

crew should be released, nor should anyone be allowed to board the vessel except the quarantine staff, until the bacteriological examination is completed and a favorable report presented. The statement or explanation of the patient, the ship's surgeon, or anyone else on board regarding the cause of the sickness should never be accepted in lieu of this precaution no matter how plausible it may be. This course should also be followed on any incoming vessel where a passenger or member of the crew presents symptoms suspicious of cholera, even though the vessel may come from a presumably noninfected area, for certain places may become infected and persons depart from them before the disease is officially recognized. Moreover, bills of health cannot be relied upon to furnish authentic information regarding the presence of infectious disease at the port of departure, for there may be persons arriving on incoming vessels, who come from interior districts, the sanitary condition of which is practically unknown to the consular service.

It is as a rule difficult to properly isolate cholera patients on shipboard and to keep under observation those who have presumably

CHOLERA

been exposed to infection. Moreover, thorough disinfection cannot be effectively carried out, while passengers and crew remain on the vessel, as the appearance of secondary cases always calls for a repetition of the latter treatment. Therefore, when a vessel on which cholera has occurred arrives at quarantine, the patient and those held for observation should be promptly removed, except in some special instance where their detention on the vessel is justifiable, otherwise an indefinite, expensive and avoidable delay to commerce may result. While at sea every effort must be made by the ship's surgeon or master of the vessel to secure isolation of the patient, to destroy or disinfect the discharge by heat if the latter is available, and to ascertain as quickly as possible the origin of the disease, whether or not the source of infection is on shipboard, and if so, to take immediate steps to remove it.

No condition ever occurs on sea or on land, where more thorough disinfection is called for than in the presence of cholera. The exact details of this work cannot be specified, as the requirements differ in each instance. On shipboard the extent and the character of disinfection required depend chiefly upon the source

PREVENTION OF INFECTIOUS DISEASES

of infection, whether this occurred before departure, or afterwards. If infection occurred before embarkation and the case was promptly recognized and isolated, the disinfection required is far less important than in instances where there is reasonable evidence that an infected center exists on the ship, in the form of a contaminated water or food supply. The disinfection is very much simplified if it is understood that cholera is contracted only through the mouth by contaminated water or food, or by the hands or articles which have been in contact with the intestinal discharges of cholera patients, and not by the general supply of clothing, bedding, etc. The only clothing which needs attention is that belonging to the sick and possibly to those in close and prolonged contact with the patient, which may be soiled with intestinal discharges. The clothing, baggage and effects of others on board and also the vessel's cargo need not be disinfected or disturbed. Articles of food and drink in the possession of the crew and steerage or third-class passengers brought from the port of departure or from sections of the interior presumably infected, unless there is reasonable evidence of its freedom from contamina-

CHOLERA

tion, should be regarded as suspicious and promptly destroyed. However, even when there is evidence of ship infection, care must be used in the condemnation of ship's stores, etc., as many articles of food, such as canned goods, unopened packages, etc., cannot be regarded as dangerous. Water tanks should receive the most careful consideration and should be disinfected and emptied if there is the slightest evidence of their being the source of infection. However, there is but little danger of this on modern passenger vessels. All china, glassware, cutlery, etc., used in connection with cases or suspected cases of cholera should be treated with boiling water. A source of cholera infection on shipboard is the general toilet rooms and water-closets. Here the most thorough and painstaking disinfection must be performed.

Great care should be taken by quarantine officers and their employés in the removal of a case of cholera from an incoming vessel, and in disinfection, etc., to avoid contracting the disease themselves and transmitting it to others. They should neither eat, drink nor smoke on board in order to avoid mouth infection—subordinates are apt to become careless about

PREVENTION OF INFECTIOUS DISEASES

these details and should therefore always work under the careful observation of a medical officer.

Rubber gloves, and also stiff-back rubber overshoes which can be removed without using the hands and which are to be disinfected with boiling water each time after use, should be worn by quarantine employ  s while disinfection is being performed. The importance of protecting the hands while dealing with cases of cholera cannot be over-estimated.

In treating certain diseases of the first class at quarantine, it is frequently deemed proper to allow some of the passengers or crew who are well, and who can be depended upon to obey instructions, to proceed with the ship to its destination. However, in the presence of cholera, this should be confined to the cabin passengers and they should be released only in instances where there is no evidence of ship or general infection and when there have been no cases or suspicious cases in their part of the vessel. The reason for this distinction has already been referred to. However, it must be understood that they are to be released only after a careful inspection, including a bacteriological examination if any suspicion exists.

CHOLERA

While cholera patients are isolated and under treatment, the most scrupulous care must be taken to prevent infection through the medium of their discharges, which should be promptly disinfected before removal from the apartment. They should not be emptied into water-closets, or elsewhere, until thoroughly disinfected. Articles, such as food, drink, glassware, china, cutlery, etc., should be similarly treated before removal from the apartment of the patient. Those who are in attendance upon the case should be held to a strict account for the enforcement of this rule, and also for the proper care of themselves. In the destruction or disinfection of discharges or infected articles or material, heat either in the form of fire, steam or boiling water plays the most important part. For disinfection in the apartment of cholera cases nothing equals boiling water; it is clearly the most valuable agent that can be used. The special advantages of this agent is its absolute certainty and rapidity of action—its availability and absence of danger and expense. A receptacle for boiling water can almost always be improvised with little or no expense. All the discharges of cholera cases held at the New York Quarantine Hospital at

PREVENTION OF INFECTIOUS DISEASES

Swinburne Island are treated in this manner. If disinfection cannot be performed in this way lime, carbolic acid and bichloride of mercury may be employed for the purpose. These must be used in sufficient amount and thoroughly mixed with the fecal material. If the feces are merely covered only superficial disinfection is accomplished.

There is no infectious disease, the suspects of which should be more carefully segregated or kept under closer observation than those of cholera. They should be constantly watched to detect any departure from the normal condition, such as weakness, loss of appetite, vomiting, diarrhœa, etc., and if any of these symptoms appear the individual should be at once isolated, the rectum swabbed, and a bacteriological examination made of the specimen obtained. The use of the thermometer to detect the invasion of cholera is of little or no value as the temperature in this disease not only may not exceed the normal register, but frequently falls below it, except in fatal cases, where the temperature may rise to a very high point preceding a fatal result.

Unusual care should be taken to insure cleanliness among suspects, and special atten-

CHOLERA

tion should be given to the inspection and disinfection of the water-closets, the glassware, crockery, cutlery, etc., used by them, as contamination may occur through the carrier of the cholera organism without any symptoms of the disease being present.

Although it is believed that the ordinary period of incubation of cholera is from one to five days, recent investigation has conclusively shown that an indefinite and prolonged period may intervene between the time when the specific organism is taken into the system of a person, and the appearance of the symptoms of the disease. Furthermore, persons known as carriers, in whose intestinal tract the organism is present, may act as media of infection and transmit the disease to others and still remain well. However, as typical cases of cholera usually occur within five days after infection it would seem that for the present the detention of suspects for more than this period may be regarded as unreasonable and unjustifiable, provided a careful inspection indicates that they are well at the termination of this time.

The existence of cholera carriers has recently been very effectively confirmed in the service of the author at the New York Quar-

PREVENTION OF INFECTIOUS DISEASES

tine Station. From one of the vessels arriving at New York, after a voyage of fourteen days from Naples, were removed to quarantine six steerage passengers who had applied for treatment for minor affections during the voyage. None of these had had intestinal trouble and were apparently well on arrival but were transferred as a matter of further inspection. After this group had been at quarantine for two days some were given two grains of calomel at bed time and on the next day a full dose of a saline cathartic. The following day one of this number was in a condition of collapse and died within 24 hours. The autopsy did not reveal the cause of death, but the bacteriological examination of the intestinal contents furnished prompt evidence of cholera, which was subsequently confirmed by an exhaustive bacteriological examination. The brisk cathartic was undoubtedly the agent which called forth the activity of the organism. A debauch has been known also to act as an exciting cause. In the instance referred to there were no other cases on shipboard that could be identified and no suspicious cases either on arrival at quarantine or in transit and not the slightest evidence of ship infection. Therefore it is reason-

CHOLERA

able to assume the patient was infected at least seventeen or eighteen days previously.

The author has also had under observation two very mild cases of cholera. In these instances the investigation indicated that the period of incubation must have been sixteen or seventeen days.

The more extended knowledge which has recently come to us regarding cholera clearly indicates that five days do not cover the maximum period of incubation, which it has been shown may involve an indefinite period, and that while the detention of a group of suspects for five days would probably cover the period of incubation of typical cases it does not offer full protection to the public. The fact that there are various periods of incubation in cholera, particularly among the milder types, and that the latter may be transmitted by carriers who show no evidence of the disease, calls for more extended means of protection against cholera than have heretofore been in operation.

In the consideration of this subject it must be fully appreciated that quarantine or the coast defense against the invasion of infectious diseases cannot offer full protection against the introduction of cholera into seaports or

PREVENTION OF INFECTIOUS DISEASES

the interior. An attempt to carry out such a measure, while it would not secure the desired result, would go far toward destroying commerce, would be impracticable and not in accord with modern sanitation chiefly for the reason that the period of incubation is uncertain and the existence of cholera carriers has been practically proven. Reasonable and practical quarantine regulations will secure a thorough inspection of passengers and crews on incoming vessels and the detention of infectious diseases if they exist on board either in a mild or typical form, and will also include other valuable means of protection. However, the detention at quarantine of those who have been exposed to cholera on shipboard, which has hitherto been looked upon as the chief means of preventing the introduction of this disease on shore, must now be considered only as a partial protection because the assumption that any period represents the maximum time that cholera infection will develop in a person is entirely theoretical, particularly in view of the fact that long periods of incubation and also cholera carriers exist. Furthermore, it would seem that the detention of suspects for more than five days, during which time typical cases would

CHOLERA

probably present themselves, is unreasonable and unjustifiable as a practical measure of protection. This brings us to a realization of the fact that hereafter each community must be prepared to accept the responsibility which belongs to it in the protection of its people against this as well as other infectious diseases, and very forcibly suggests what practical sanitarians have long hoped, i. e., the presence in each town and city of a health officer or health officials who are practically as well as theoretically familiar with infectious diseases, who understand the importance of their early detection, either in the typical, mild or irregular form—an exceedingly important factor in the control of outbreaks.

Apparently what we have recently learned in regard to cholera would show that our defense against it is much weaker than we have hitherto believed. This is not the fact. There is an extremely optimistic side to this subject and one which has practical and scientific support. The belief has long existed that the ravages that cholera and other infectious diseases have caused in the East are indicative of what would occur if these diseases were to enter any community. This has been the key-note of state-

PREVENTION OF INFECTIOUS DISEASES

ments frequently made by alarmists. This belief is without any reasonable or logical foundation whatever, and it may be safely stated that where modern sanitary regulations are in force such conditions will never occur. On the contrary, in the absence of a general infection cholera does not extend rapidly, and where proper sanitary regulations are in force should soon disappear. A general infection either on shipboard or on land is often a serious and justifiable reflection on whoever may be in charge of the health of those either on the vessel or on land.

As cholera carriers and mild and irregular cases of this disease may enter a community practically unannounced it is necessary that departments of health should be prepared to deal with such emergencies, particularly at times when there is known to be danger of the introduction of cholera. A rigid investigation should be made in cases where certificates give as the cause of death gastro-enteritis or intestinal trouble of any kind. This should always include a bacteriological examination. Cases of diarrhœa, cholera-morbus, etc., which come under the observation of the family physician should be also subjected to careful bac-

CHOLERA

teriological examination. The effect of this is to secure the early detection of cholera, either in a typical or irregular form, and when this is done and in the absence of general infection it is reasonably certain that no serious result will follow so far as the extension of the disease is concerned.

It would seem reasonable that in the future we must recognize that isolated cases of cholera may appear anywhere which has known or unknown intercourse with cholera-infected places, and the possibility of this must be recognized, but it must also be understood that, while this is so, if general infection is guarded against and proper precautions are taken in individual cases, even the same that are properly carried out in the presence of typhoid fever, we may, as a rule, dismiss the idea of serious results to a community.

Bacteriological examination should always be included in determining the presence of cholera. This refers to the examination of alvine discharges or the material taken from the rectum by swabs. At the New York Quarantine Laboratory it has been found that nearly half of the general examinations of this kind, even where there was no clinical evidence or special

PREVENTION OF INFECTIOUS DISEASES

reason to suspect cholera, showed curved bacilli of various sizes and shapes. In many instances these organisms resembled the cholera vibrios. Where the latter forms are numerous in this examination, the case should be regarded as suspicious until the cultural characters prove it to be otherwise. The presence of a few actively motile organisms in the hanging drop adds considerably to the suspicion.

In cholera carriers and mild cases of this disease the cultures may show the vibrios even though the smear shows very few suspicious organisms. It is usually only in the active cases that the smear and hanging drop, made directly from the discharges or rectal swab, will afford such unmistakable evidence as is required to pronounce the case true cholera from the point of view of the bacteriologist. In all other cases it is necessary to isolate pure cultures and prove them cholera vibrios or otherwise by suitable bacteriological tests. These tests are usually completed within 24 to 36 hours.

CHAPTER VIII

PLAGUE

PLAGUE like other infectious diseases does not always assume a typical form and sometimes, particularly at the beginning of an outbreak, is not recognized. In its early stage it may be confounded with other acute febrile conditions such as typhus fever, or in the pneumonic form it may be mistaken for pneumonia, or some affection of the respiratory apparatus. However, with the exception of cases which prove rapidly fatal and in the pneumonic form of the disease, buboes due to inflammation of the lymph glands usually occur, more commonly in the inguino-femoral region, although they may appear in the axilla or elsewhere. This sign is of the greatest diagnostic value, and should receive the most careful consideration in the examination of passengers and crews on vessels where plague has appeared or which arrive from ports or sections where this disease exists.

PREVENTION OF INFECTIOUS DISEASES

It is now generally accepted that plague is commonly transmitted to man by rats through the medium of the fleas which infest them. There are some who believe that plague is transmitted only in this way. The rat theory has become so popular, that the probability of infection occurring by other means has received but comparatively little consideration, although many careful investigators, while accepting the belief that the rat may be the ordinary medium of infection, are satisfied that the disease is transmitted in numerous other ways. There can be no doubt that in the pneumonic form the disease is transmitted directly from one person to another by the discharges from the respiratory tract, and it is yet to be proven that in the more common, or bubonic form of plague, other agents besides the fleas from rats do not act as media of infection, for outbreaks have occurred where reasonable evidence has been presented to show that the disease was not transmitted in this way.

Outbreaks of plague occurring at seaports are usually attributed to the presence of infected rats, which have escaped from some incoming foreign vessel, although there has not been an abundance of authentic evidence to

PLAGUE

prove this, and the belief that plague is chiefly transmitted in this manner is supported largely by inference. This assumption is not only unfair to commerce, but interferes with a more careful investigation as to the cause of the outbreak. A mild or unrecognized case of plague infected at a port of departure, or in some interior district, may develop during the transit of the vessel, and not be recognized as plague, and reaching the port of destination may in some way cause an outbreak of the disease without the vessel or its contents being directly responsible for it.

It is not the author's intention to minimize in any way the danger of the rat as a medium of infection. It is proper, however, that a word should be said in opposition to the belief that plague is transmitted only in this manner, as this exclusive theory tends to discourage more thorough and extended investigation. A more liberal view of the subject need in no way interfere with the enforcement of all reasonable and practicable regulations for the destruction of the rat.

It is very important to determine whether or not a case of plague occurring on shipboard was contracted before or after leaving the

PREVENTION OF INFECTIOUS DISEASES

port of departure, as this has a direct bearing on the treatment of the vessel, passengers and crew at quarantine. In deciding this the maximum period of incubation of the disease must be reckoned with. Practically, this is believed to be not more than eight days. As a rule the invasion occurs within a much shorter period, probably within four or five days after infection. A knowledge of this is also necessary in dealing with suspects, or those held for observation. Sometimes an early invasion may not be detected if the case is a mild one, or the period of incubation may possibly extend over a longer period than eight days, and the question of plague carriers is yet to be dealt with.

If a vessel arriving at quarantine from a plague infected port has been eight days or more in transit, and a thorough inspection of those on board shows that all are well, there is no reason why the passengers or crew should be detained, or why it should be assumed that there are infected rats on the vessel.

If plague is found on an incoming vessel at quarantine, and satisfactory evidence is presented to show that the patient was infected before the departure of the vessel, the action

PLAGUE

to be taken by the quarantine officer is comparatively simple. Fortunately as a rule when this disease occurs on shipboard it is on freight vessels coming from eastern ports with comparatively small crews and few if any passengers. After the patient has been removed and all on board have been examined, the quarantine officer must decide who shall be detained, and who shall be allowed to proceed with the vessel. If the officers are found to be well, and can be relied upon to obey instructions, which is usually the case, they may be permitted to proceed with the vessel to the dock, and there be subjected to a daily examination, as their transfer at quarantine would seriously interfere with the management of the vessel. The crew, however, cannot be depended upon to remain on shipboard or to obey instructions, and therefore should be removed at quarantine for the period of incubation of the disease. Where plague is found on a vessel carrying passengers, it must also be decided which of the latter shall be allowed to proceed with the vessel. This will depend on the probable origin of the disease, the class of persons dealt with, their responsibility, destination, etc.

The general examination of plague suspects

PREVENTION OF INFECTIOUS DISEASES

should consist not only of a visual inspection, but should include the use of the thermometer, and also a glandular examination. The latter should always be applied to the crews of vessels coming from the East, many of whom are natives, and are more apt than others to be infected with this disease. This precaution should be taken when a person becomes ill on a vessel arriving from a plague infected port or section. A number of instances have occurred where plague has been detected only in this way. Buboes, however, do not always indicate plague, and enlarged inguinal glands are frequently found among sailors and others due either to venereal disease or some unknown cause. This fact must also receive careful consideration.

In some instances plague appears on vessels after they have been long in transit, and for this reason it is assumed that infected rats and fleas are on board. Before this explanation is accepted as final, the possibility of the case having been infected before departure and remaining unrecognized for some time should be excluded, as mild cases may not be detected for a long period or may remain unrecognized, and possibly from them secondary cases of the dis-

PLAGUE

ease may occur, contracted through some other medium than the fleas from a rat. Where there is no ship's surgeon present, masters of vessels, particularly those coming from the East, frequently do not report cases of sickness which are mild or in their opinion are not suggestive of an infectious disease. Therefore, it is always safer to consult the ship's log, and the captain should be required to give a detailed account of any recorded sickness which may have occurred during the voyage. Neglect on the part of the quarantine officer to secure this important information is not infrequently a cause of error in deciding the origin of infectious disease on shipboard.

In view of the present accepted theory of plague infection, disinfection becomes rather an unimportant factor in dealing with this disease, and is confined largely to instances of the pneumonic form where infection is transmitted by the discharge from the respiratory tract, to septic cases, to the surgery connected with buboes, and to the belongings of the patient. General disinfection is not required for clothing, baggage, cargoes of vessels, food, drink, etc.

The principal preventive measures called

PREVENTION OF INFECTIOUS DISEASES

for both on shipboard and on land are believed to be the destruction of rats. Unfortunately, the means, which are sometimes employed for this purpose are unreasonable and unjustifiable. They cause unnecessary delay and expense to commerce and the public and are of little or no avail. While the means of destroying this vermin on land may be carried out with but few complications or interference with the public, on shipboard it becomes a more difficult problem because rats are principally in the hold of the vessel which is usually filled with cargo. Notwithstanding statements to the contrary, a vessel's cargo cannot be disinfected, while it remains in the vessel, nor can sulphur dioxide, which at present is the most effective agent employed for the destruction of rats, be depended upon to kill them in the hold of the vessel until after the cargo has been removed. It may kill a few of them, but half-way measures do not conform to the principles which should be followed in this or any other form of sanitary work. If it is suspected that infected rats are on board, they should not only be destroyed, but should also be removed from the vessel. If an attempt were made to properly carry this measure out at quarantine, it would involve

PLAGUE

the removal of the vessel's cargo, which is an exceedingly long and expensive operation involving as it does the transfer of the cargo on lighters from the vessel to its destination. Such action on the part of the quarantine officer is justifiable only in extreme instances, and there is no good reason, if proper precautions are taken, why the destruction and removal of the bodies of the rats cannot be accomplished after the vessel has reached its destination.

During the year 1899, formidable outbreaks of plague occurred in Rio Janeiro, Santos and other Brazilian ports, from which vessels frequently arrive at New York. For two months after appearance of the outbreak, as a matter of extreme precaution and also as a test, the cargoes of vessels coming from these ports were removed at the New York Quarantine Station and placed on lighters, in order to destroy the rats in the holds of these vessels and to secure their bodies for bacteriological investigation. Those found were removed in covered metallic receptacles to the laboratory, but in no instance was there any evidence of plague infection found among them, although a case of plague was found on two of these vessels.

PREVENTION OF INFECTIOUS DISEASES

However, in both instances it was satisfactorily shown that the patients were infected on shore and not on shipboard. When it is regarded as necessary to secure the bodies of rats on an incoming vessel, a quarantine officer should proceed with the latter to its destination to see that proper means are enforced to prevent the escape of this vermin during the removal of the cargo and to secure their destruction after the vessel is empty. The means which are generally employed for this purpose include the use of metallic funnels placed on the cables which bind the vessel to the dock and which may be used by rats for escape, properly guarding the vessel, etc. After the cargo is removed, sulphur dioxide should be generated in the hold of the vessel to kill the rats; the combustion of one pound of sulphur for every 1,000 cubic feet of estimated space in the hold of the vessel will be sufficient for this purpose. During the generation of the gas the hatches should be carefully closed. Experiments at the New York Quarantine Laboratory show that the combustion of even a less amount of sulphur than one pound for every 1,000 cubic feet of space will promptly kill all rats which may be exposed. At the expiration of about six hours the hatches

PLAGUE

should be opened, and the dead rats picked up with tongs, or with the hands properly protected and placed in paper bags or some other inexpensive receptacle and carried to the ship's furnace, and there incinerated, provided they are not to be subjected to a bacteriological examination. If so, they should be removed in properly covered metallic receptacles to the laboratory. The method just referred to involves but little delay or expense and is an efficient means of destroying this vermin, and may prudently be carried out on all vessels coming from plague infected ports, whether or not this disease has occurred on shipboard. If this procedure is followed for two or three voyages, and care is taken that rats do not re-enter the vessel, the latter will soon be rid of this medium of infection and the danger of transmitting plague in this way will be reduced to the minimum.

Vessels plying between New York and plague infected ports are subject to the following quarantine regulations regarding the destruction of rats. The captains of these vessels are required on arrival at the New York Quarantine Station to present an affidavit that every precaution has been taken to prevent rats en-

PREVENTION OF INFECTIOUS DISEASES

tering the vessel while at the port of departure, and that while at the latter place and during the transit of the vessel means were taken to catch and destroy them by incineration. One of the first trials of this regulation accomplished the destruction of 35 or 40 rats, and on a subsequent voyage of the same vessel but two or three were found.

Whatever theory may be accepted regarding the medium of infection, the practical and scientific means of preventing the transmission of plague from one section of the world to another consist principally in the enforcement of stringent regulations at the port of departure, in the way of detention under medical observation of all who have come from infected districts, careful supervision of the crew as to the places they frequent while in port, etc., and the employment of all practical means to remove rats from a vessel before loading it, and to prevent others from reaching it. The latter procedures are not difficult and simply require a little attention and energy to carry them out, whereas the effect is to practically remove the rat as a factor in the transmission of plague from one part of the world to another.

CHAPTER IX

DISINFECTION

THE treatment of clothing, bedding, baggage, cargoes of vessels, apartments, etc., for the purpose of preventing the transmission of disease, is referred to in the earliest medical literature, therefore its origin was evidently a product of the fomites theory; for this practice was in operation long before there was any known scientific investigation or bacteriological research in connection with this subject. As the fomites theory may be regarded as fallacious and does not now receive the general support of practical sanitarians, it is essential that the conditions or circumstances under which disinfection is to be employed and the agents which are to be used should receive careful consideration in order that this subject may be dealt with from a standpoint of modern sanitation. In recent years disinfectants have been exhaustively studied, and their germicidal power more or

PREVENTION OF INFECTIOUS DISEASES

less definitely determined, but the necessity for their use is still largely theoretical.

Prior to the scientific investigation of this subject, the preparation or manufacture of disinfectants, or alleged disinfectants, was largely in the hands of those who knew little or nothing of the germicidal value of these agents, but secured a very substantial profit from the sale of solutions and powders advertised to prevent the transmission of infectious disease, which, owing to their composition or method of employment, were as a rule practically worthless. Even at the present time preparations of this kind may still be found in the market and are extensively used by the public with the belief that in some way they are instrumental in keeping infectious diseases away from the household.

It is commonly supposed that no special or technical knowledge is required to perform disinfection. This error has been largely responsible for worthless and farcical attempts to carry out this means of protection when it is really called for. Families often determine their own plan of disinfection, and it is not uncommon to find in the patient's apartment a saucer of carbolic acid or some other fluid

DISINFECTION

placed somewhere in the room, the burning of small pieces of sulphur, or the presence of textile fabrics soaked in a so-called disinfecting solution. The truth is that an apartment cannot be disinfected while occupied; for instance, the generation of sulphur dioxide or formaldehyde gas in an amount sufficient to secure germicidal result is incompatible with respiration in the human being. Therefore an attempt to disinfect a room with these agents while occupied is not only worthless, but a great annoyance, and in certain diseases not without some danger to the patient. Disinfecting solutions either in receptacles or sprayed about the room are from a practical standpoint equally valueless.

The rather extravagant idea on the part of the public regarding the necessity for the extended use of disinfectants has unfortunately received more or less official endorsement. For instance, in order to allay the fears of a family in which a case of infectious disease has occurred, attempts are not infrequently made to disinfect the entire house. Even if pathogenic organisms were present and distributed about generally, and were sufficiently active to transmit disease, the means which are usually em-

PREVENTION OF INFECTIOUS DISEASES

ployed to carry out this drastic measure would not destroy them. To insure such a result would be exceedingly difficult, expensive and often destructive to the contents of an apartment; besides, it would be difficult to indicate a condition where such an extreme measure would be justified or called for.

The so-called disinfection of the contents of a privy-vault offers one of the best illustrations of the misconception which exists regarding this subject. Practically the contents of a privy-vault cannot be disinfected. These receptacles usually contain a large amount of human excreta which could only be disinfected by thoroughly mixing the entire mass with a disinfectant to the extent of insuring complete incorporation. The conditions would be very exceptional when one would resort to such an impractical, prolonged and offensive measure. The disinfection of the contents of a privy-vault as it is generally recommended consists in the use of chloride of lime or some other germicidal agent either in solution or powder thrown over the surface of the mass. While this will to a certain extent act as a deodorant if freely and frequently applied, it has no real value in this instance as a disinfectant or in protecting

DISINFECTION

against the possible transmission of infection, for instance, to nearby wells through this source if the contents of the vault should happen to contain pathogenic organisms, for the reason that the disinfectant employed comes in direct contact with but a very superficial part of the mass. From a sanitary standpoint, so far as the privy-vaults which are in ordinary use are concerned, there is not the slightest justification or excuse for their existence. Receptacles of this character when it is necessary to use them should always be placed above the surface of the ground and not below it, in order that they may be easily emptied and cleaned, and to provide for an air space below and about them, and to exclude the principal source of danger—ground contamination.

What has been said in regard to the alleged disinfection of privy-vaults and their contents to a great extent applies to the ordinary method of treating other collections of infected matter. For instance, the usual means employed to disinfect the stools of typhoid fever patients are frequently as worthless as the attempts which are made to disinfect the contents of privy-vaults. The methods commonly adopted consist in adding to the discharges some form of

PREVENTION OF INFECTIOUS DISEASES

a disinfectant in solution, commonly chloride of lime or carbolic acid, which may or may not be stirred with the mass and allowed to stand for a while—and then emptied into the water-closet or privy-vault. To rely upon this on the theory that it may do some good is not a safe or scientific conclusion. Furthermore, the discharges from the respiratory tract, etc., etc., which are usually tenacious and difficult for powders or fluids to penetrate, are also not often disinfected by the means usually employed for this purpose.

The author's investigation in connection with this part of the subject demonstrated that where fecal matter is placed in a solution of chloride of lime or some other disinfectant, it requires about twenty hours or even longer to penetrate about $\frac{1}{8}$ of an inch of the mass and disinfect it. The same conclusions were reached in similar experiments carried out by Dr. William H. Park of the New York City Department of Health.

So far as we know at the present time, the only sure means of rendering infected discharges absolutely harmless is by some form of heat or by thoroughly mixing every particle with a powerful disinfectant.

The necessity for the disinfection of money,

DISINFECTION

rags, clothing, baggage and cargoes of vessels, etc., has long been under discussion, and various views are held regarding it. However, scientific investigation and practical experience have shown that these articles, with the probable exception of the clothing and effects of those actually sick, do not transmit disease except in rare instances, and that their disinfection with the exceptions referred to is unnecessary and uncalled for. This part of the subject has already been discussed in a previous chapter.

So far as money is concerned an attempt to disinfect it would constitute one of the most unjustifiable and impracticable acts that a health official could venture upon. Paper money in bulk could be disinfected only by steam, as no other disinfectant would have sufficient penetration for the purpose. This treatment particularly in connection with old bills, which contain more or less foreign or organic matter, would cause money to cohere and otherwise de-face and injure it; moreover, the question may be pertinently asked in what manner could money be withdrawn from circulation for the purpose of disinfection, by whom would this work be performed, and how often would the treatment be required? From a practical

PREVENTION OF INFECTIOUS DISEASES

standpoint, the impossibility of this action is apparent, and it is fortunate that careful investigation has presented reasonable evidence that money does not constitute a menace to the public health.

It has been shown by experimental work that no agent can be depended upon to penetrate and disinfect rags while in bales; therefore, if this treatment were required it would be necessary to break open the bales; even then no other agent but steam could be depended upon to penetrate this material. This would involve an expense almost equal to the value of the rags, particularly if they were to be rebaled. It is important therefore to know that except possibly in some rare instances the disinfection of rags is not required.

It is fortunate that cargoes of vessels do not constitute a menace to the public health, for their disinfection would involve great delay and expense to commence, as it would be necessary to remove them from the vessel for this purpose, notwithstanding that a contrary view is held, and that attempts are not infrequently made to disinfect a ship's cargo before its removal, by the introducing of sulphur dioxide or formaldehyde gas into the hold of the vessel.

DISINFECTION

Clothing and personal effects are most closely associated with the fomites theory. While there are those who are willing to concede that money, rags, cargoes of vessels, etc., may not act as a medium of infection except in rare instances, they are tenacious of the belief that the clothing and effects, even of those who are well, are common agents in the transmission of disease. In a previous chapter it has been shown that scientific investigation and practical experience do not support this theory.

It is the discharges and the material which contains the discharge of those who are actually sick with infectious disease that should be regarded as the media of infection, particularly the discharges, which in certain of these diseases, such as cholera, constitute the most dangerous if not the sole medium of infection. Too much emphasis cannot be given to this statement.

Those who are responsible for the public health and the enforcement of sanitary measures are frequently tempted to impose certain regulations not because they are really required or are dictated by scientific consideration or practical experience, but rather to be on the safe side. It is largely a policy of this

PREVENTION OF INFECTIOUS DISEASES

kind that is responsible for the unnecessary use of disinfectants.

In the consideration of the subject of disinfection, it is not out of place to repeat what has already been said: that the prevention of infectious disease is secured chiefly by thorough inspection to promptly detect cases of these diseases and to insure their strict isolation. General disinfection cannot be used as a substitute for these precautions.

The value of disinfection is most conspicuously shown in the treatment of infected discharges. Far greater protection will be afforded by the proper cleaning and disinfection of the hands of those attending the patient than by the treatment of their clothing, although in certain rare instances, such as have been referred to, the disinfection of the latter may be justified. Reports are occasionally made that surgical cases are infected through the medium of the clothing of those previously in contact with cases of scarlet fever, etc. There can be no reasonable doubt that if in these instances infection actually occurred, it was through the medium of the hands rather than the clothing.

The necessity for the disinfection of the

DISINFECTION

apartment itself at the termination of a case of infectious disease is open to considerable doubt, and there is good reason to believe that where strict cleanliness has been observed throughout the disease, and all discharges are promptly disinfected and destroyed by heat preferably and all dressing and material used about the patient are similarly treated, there is, as a rule, but little else required at the period referred to but the vigorous and thorough use of soap and water and full exposure of the apartment to the air and sunlight. The great importance of cleanliness, particularly soap and water, in the prevention of infectious disease is surely not recognized.

As a résumé it may be said that the value of disinfection is more apparent during the activity of a case of infectious disease than at its termination. For this reason discharges and presumably infected material should be dealt with as soon as they can be secured. Nothing is more antagonistic to modern sanitary methods than to allow discharges, etc., to accumulate for final or even occasional disinfection. Material of this character should be dealt with at the earliest moment and in the most effective manner. The necessity for the

PREVENTION OF INFECTIOUS DISEASES

treatment of the room itself is a matter which depends chiefly on the means which have been taken during the course of the disease to preserve cleanliness, to insure prompt disinfection of discharges, etc.

The true meaning of the word "disinfectant" is not generally understood. It is commonly confounded with antiseptics, deodorants, fumigants, etc. Properly speaking no agent is a disinfectant which does not destroy the organisms with which it is brought in contact, while antiseptics only hold in check or inhibit their propagation, but do not necessarily destroy them. Deodorants neutralize or mask offensive odors, and may have no definite germicidal value. The term "fumigation" applies to disinfection by means of gaseous agents such as sulphur dioxide, formaldehyde, etc. This term is unscientific and undesirable and should be discontinued.

The bacteriological investigation of disinfectants, which may be said to have had its origin in the early work of Pasteur and Koch, has caused the elimination of many worthless articles which have long enjoyed the reputation of being valuable germicides. Of the innumerable agents which in the past have been em-

DISINFECTION

ployed in general disinfection but few can be depended upon for this purpose. These are heat, sulphur dioxide and formaldehyde gas, bichloride of mercury, carbolic acid, and lime.

A second group including zinc, copper, iron, etc., is sometimes employed for disinfection. However, these are of very doubtful germicidal value, and cannot be compared to the first mentioned, and there is but little or no justification for their employment as practical disinfectants. It is quite probable that the power of neutralizing odors, which some of this group possess, has improperly credited them with being germicidal agents.

The value of the first group when properly employed has been clearly and conclusively determined, and places in our hands means by which infected matter or material may be rendered harmless. Every community should have some means of performing public disinfection. It is an economical enterprise as well because it renders safe presumably infected articles, which otherwise would be destroyed. The loss thus entailed during an outbreak of infectious disease even in a small town is considerable and would probably exceed the expense of at least a small steam disinfecting apparatus. In late

PREVENTION OF INFECTIOUS DISEASES

years great progress has been made in perfecting the latter, which may now be purchased of almost any size and at a reasonable price.

In the consideration of disinfectants, their value as germicides, and the strength or power in which they are to be used, it should be remembered that the pathogenic organisms which usually cause diseases in human beings have no spores; therefore, it is not necessary under ordinary circumstances to provide measures to destroy them. It should also be understood that modern sanitation demands that the composition of all agents employed for disinfection shall be known, and their germicidal value determined by careful bacteriological research before they are made use of.

CHAPTER X

DISINFECTANTS

STEAM

HEAT in the form of steam is the most valuable and practical agent known for the disinfection of clothing, bedding, etc. Its action is rapid and when properly employed is destructive to all organisms and their spores with which it may be brought in contact. Steam has the power of penetration possessed by no other disinfectant. This is of great importance particularly in public disinfection, where in order to secure economy of space and the prompt identification of clothing, bedding, etc., it is necessary to have the material rolled into packages. In this arrangement no germicidal agent but steam can be depended upon to disinfect.

The results obtained by steam depend largely upon the apparatus used. The disinfecting chambers originally employed for this purpose were faulty in many ways and not only was

PREVENTION OF INFECTIOUS DISEASES

considerable time required to secure the necessary temperature, but after disinfection was completed the means of releasing the steam were comparatively crude as were many other details connected with the working of the apparatus. The delay in securing a proper degree of temperature in the early apparatus was due to the presence of air in the closed chamber which is a bad conductor and is penetrated very slowly by heat; and it frequently required the greater portion of an hour to secure a temperature of 200° F. Therefore, it soon became evident that in order to obtain prompt and satisfactory results it would be necessary to remove from the chamber at least a part of the contained air before introducing the steam. This is now accomplished by a vacuum apparatus, which has become an important part of a modern steam disinfecting chamber. A vacuum of 20 inches, which represents the removal of about two-thirds of the air in the chamber, is generally obtained before the steam is allowed to enter. By this means the necessary degree of temperature may be secured in five or six minutes, and greater penetration of the material to be treated is also obtained. The vacuum is also employed after disinfection is completed,

DISINFECTANTS

and before the door of the apparatus is opened, not only to remove the steam introduced into the chamber for disinfection, but also to cause the rapid drying of the goods undergoing disinfection in the apparatus, which are saturated by the steam during this process. Articles treated in this way may be used almost immediately after they are removed and exposed to the air.

The following account of the steam apparatus used on board the disinfecting steamer *James W. Wadsworth* at the New York Quarantine Station may in a general way be accepted as a description of a modern steam disinfecting plant.

This apparatus consists of a rectangular-shaped chamber 7 feet long and 4 feet in both diameters, composed of two shells with a space of about $11\frac{1}{2}$ inches between them. The shells are made of 5-16 inch open hearth flange steel, riveted at the ends to heavy cast iron rings or door plates, the outer surfaces of which are recessed, and contain $11\frac{1}{2}$ inch "T" shaped rubber joints for the purpose of making the doors air-tight. The latter are of a convex type, swing on cranes, and are fastened to the chamber with turn buckles. For the recep-

PREVENTION OF INFECTIOUS DISEASES

tion of the material to be disinfected the chamber contains an iron framework car, the sides and floor of which are constructed of heavy galvanized iron netting in order to properly hold in place the material to be treated. A movable track is arranged so that the car may be withdrawn from either end of the chamber. The steam enters through a $2\frac{1}{2}$ inch pipe to a reducing valve, which limits the pressure of the steam entering the chamber to the desired limit. About ten pounds' pressure is generally used in the chamber during disinfection, a vacuum is obtained by a steam exhauster, which acts on the principle of a syphon and is so arranged that it will draw either from between the shells or from the interior of the chamber.

The rapid drying of the goods in the chamber before the door is opened, accomplished by the method above described, is of the greatest value in quarantine work, where it is necessary to release detained vessels at the earliest moment.

To accurately ascertain the temperature of the interior of the chamber a thermometer connected with a brass plate on the inner surface of one of the doors is placed on the outside of the latter. The entire outer surface of the chamber is encased in a $1\frac{1}{2}$ inch layer of asbestos

DISINFECTANTS

magnesia, which retains the heat in the chamber and prevents outside radiation.

Steam disinfecting apparatus similar in construction to the one described are now made of almost any size, and improvements in their detail frequently take place.

The experiments with steam as a disinfectant made by the author at the New York Quarantine Station, during 1896-97, consist of two series of tests: First, to determine the influence of the vacuum in rapidly securing high temperatures; second, to ascertain the practical value of steam as a disinfectant.

In both series a carefully tested self registering thermometer was placed in the center of each package in order that its inner temperature could be compared with the temperature of the chamber. Tightly rolled packages of paper were used in all tests because they offered very effective opposition to penetration.

FIRST SERIES

The effect of the vacuum in favoring penetration was more apparent in short exposures. In longer ones the difference in the temperature as shown by the thermometers in the pack-

PREVENTION OF INFECTIOUS DISEASES

ages was not so great. For instance, in Table I. it is shown that with a chamber temperature of 240° F., the thermometer within a package of paper, weighing two pounds, after exposure of three minutes with vacuum registered 210° F., while the temperature in the center of the package of paper of the same weight with the same exposure without vacuum was only 160° F., a difference of 50° F., whereas, in Table II., with a chamber temperature of 234° F., after an exposure of ten minutes, the difference in the temperature in the center of a package of paper, weighing two pounds, with vacuum and in one of the same weight and exposure without the vacuum was only 12° F.

Furthermore, the value of the vacuum is more apparent in treating packages of paper, where the resistance to the penetration of steam or heat is more pronounced. This is shown in Tables I. and II., where the thermometers when wrapped in cotton sheets, which are easily penetrated, showed about the same degree of temperature with and without vacuum.

In Table I. a bag of woolen clothing weighing seven pounds, with an exposure of three minutes to a chamber temperature of 240° F.,

DISINFECTANTS

TABLE NO. I.

ARTICLE.	Weight.	Subject to degree of temperature.	Time of exposure.	Thermometer in package registered.	
				With Vacuum	Without Vacuum
	Lbs.	°	Min.	°	°
Newspaper	1	240	3	240	200
Newspaper	2	240	3	210	160
Newspaper	2	240	3	210	160
Newspaper	3	240	3	200	110
Newspaper	3	240	3	200	111
Newspaper	3	240	3	220	120
1 cotton sheet	1	240	3	240	240
2 cotton sheets	2	240	3	239	237
1 double bed blanket	4	240	3	239	185
2 double bed blankets	8	240	3	203	110
1 ordinary house rug	7	240	3	238	235
1 bag woolen clothing	7	240	3	173	108

TABLE NO. II.

ARTICLE.	Weight.	Subject to degree of temperature.	Time of exposure.	Thermometer in package registered.	
				With Vacuum	Without Vacuum
	Lbs.	°	Min.	°	°
Newspaper	1	234	10	230	218
Newspaper	2	234	10	212	200
Newspaper	3	234	10	190	170
2 double blankets..	8	234	10	215	190
2 sheets	2	234	10	230	229
1 bag woolen clothing	7	234	10	230	232

PREVENTION OF INFECTIOUS DISEASES

showed an inside temperature of 173° F., with vacuum, and in a package of the same kind and weight with the same chamber temperature and exposure, the temperature inside registered only 108° F., without vacuum; whereas, in Table II., with a longer exposure (10 minutes), a bag of clothing weighing seven pounds showed practically the same inside temperature without vacuum as occurred in a package of the same character with vacuum, both about equal to the temperature of the chamber.

In Table III., where the experiments were made with packages of newspapers, the advantage of the vacuum is again evident.

TABLE NO. III.

ARTICLE.	Weight.	Subject to degree of temperature.	Time of exposure.	Thermometer inside package registered.
<i>With vacuum:</i>	Lbs.	°	Min.	°
Newspaper	2	230	10	215
Newspaper	2	230	10	195
Newspaper	3	230	10	170
<i>Without vacuum:</i>				
Newspaper	2	227	10	133
Newspaper	2	227	10	174
Newspaper	3	227	10	120

DISINFECTANTS

It was observed in the study of these experiments that the degree of temperature registered in the inside of packages of the same material and weight and subjected to practically the same temperature was not always uniform. This was undoubtedly due to some difference in the preparation of the packages which it was impossible to avoid. As a rule if the material was more tightly wrapped the inside temperature was correspondingly lower.

Tables IV. and V. show that as the degree of temperature in the chamber was lowered the penetration was correspondingly less. In these tests there was no pressure in the chamber, the indicator registering zero. It will be seen by referring to Table I. that in the package con-

TABLE NO. IV.

ARTICLE.	Weight.	Subject to degree of temperature.	Time of exposure.	Thermome- ter inside package registered.
	Lbs.	°	Min.	°
<i>With vacuum:</i>				
Ordinary house rug.....	7	170	10	100
Newspaper	1	170	10	137
Newspaper	2	170	10	120
Newspaper	3	170	10	107
2 double rose blankets.....	8	170	10	120
2 sheets	2	170	10	122

PREVENTION OF INFECTIOUS DISEASES

TABLE NO. V.

ARTICLE.	Weight.	Subject to degree of temperature.	Time of exposure.	Thermometer inside package registered.
	Lbs.	°	Min.	°
<i>Without vacuum:</i>				
1 rug	7	200	10	105
Newspaper	1	200	10	160
Newspaper	2	200	10	120
Newspaper	3	200	10	100
2 double rose blankets.....	8	200	10	135
2 sheets	2	200	10	165

taining two cotton sheets penetration was very easily effected, the thermometer inside the package being within four degrees of the temperature of the chamber (240° F.) after an exposure of only three minutes, while Table IV. shows a difference of 48° F. between the temperature of the chamber (170° F.) and the temperature inside the package of sheets after an exposure of ten minutes. This marked difference is also seen in Table V.

The results given in these tables have been repeatedly verified by the author, and show conclusively the value and necessity of using a vacuum in connection with steam disinfection.

DISINFECTANTS

SECOND SERIES

In order that there could be no doubt as to the vitality of the micro-organism used in the second series of experiments, the cultures were freshly prepared in each test and their virulence maintained by the inoculation of guinea-pigs and white mice. Sterilized linen disks, soaked in bouillon cultures and enclosed in cotton, woolen and paper envelopes, were placed inside the packages used in the experiments.

It was found that when disks soaked in cultures of plague and diphtheria were placed in open petri dishes and laid on the floor of the steam chamber, and were subjected to a direct temperature of 155° F., for fifteen minutes, no growth occurred. This result was usually obtained at even a lower temperature (135° F.). A chamber temperature of 155° F., however, would not produce more than 100° F. within a package of clothing, etc., which would manifestly be insufficient for disinfection even with a long exposure.

In the second series of experiments, the test packages were removed from the chamber in each experiment after the exposure was com-

PREVENTION OF INFECTIOUS DISEASES

pleted and the disks contained therein placed in tubes containing bouillon, and were kept in the incubator for at least a week before a final decision as to the growth of the bacilli was made.

The facts relative to penetration, etc., established in the first series of experiments corroborate the tests made in the second series and show that when packages were subjected to low temperatures growths usually occurred. It is unsafe to compute too closely the degree of heat necessary for germicidal action, and considerable margin should be allowed. It is reasonable to assume that a temperature of at least 155° F., should be secured inside a package prepared for disinfection.

Tables I. and II. (second series) show that where packages containing disks were subjected to comparatively low temperatures the results were variable.

TABLE I.—WITH VACUUM.

Temperature 170° F. Time of exposure, 10 minutes.

Plague:—

- | | |
|-------------------------------------|-----------|
| 1. Sheet of paper and envelope..... | No growth |
| 2. Newspaper, 1 pound..... | Growth |
| 3. Newspaper, 2 pounds..... | Growth |
| 4. Blanket | Growth |

DISINFECTANTS

Diphtheria:—

1. Sheet of paper and envelope.....	No growth
2. Newspaper, 1 pound.....	No growth
3. Newspaper, 2 pounds.....	Growth
4. Blanket	No growth

Anthrax:—

1. Sheet of paper and envelope.....	No growth
2. Newspaper, 1 pound.....	No growth
3. Newspaper, 2 pounds.....	Growth
4. Blanket	Growth

TABLE II.—WITH VACUUM.

Temperature 200° F. Time of exposure, 10 minutes.

Plague:—

1. Sheet of paper and envelope.....	No growth
2. Newspaper	No growth
3. Newspaper, 1 pound.....	Growth
4. Newspaper, 2 pounds.....	Growth
5. Blanket	No growth

Diphtheria:—

1. Sheet of paper and envelope.....	No growth
2. Newspaper	No growth
3. Newspaper, 1 pound.....	No growth
4. Newspaper, 2 pounds.....	Growth
5. Blanket	No growth

Anthrax:—

1. Sheet of paper and envelope.....	No growth
2. Newspaper	Growth.
3. Newspaper, 1 pound.....	¹
4. Newspaper, 2 pounds.....	Growth
5. Blanket	Growth

In experiments enumerated in the following table (III.) the temperature of the steam chamber was raised to 215° F., and for the first time the bacilli were killed in all the packages.

¹ Tube of bouillon containing infected disk broken.

PREVENTION OF INFECTIOUS DISEASES

TABLE III.—WITH VACUUM.

Temperature 215° F. Time of exposure, 10 minutes.

Plague:—

1. Sheet of paper and envelope.....	No growth
2. Book, 600 pages.....	No growth
3. Newspaper, 1 pound.....	No growth
4. Newspaper, 2 pounds.....	No growth
5. Blanket	No growth

Diphtheria:—

1. Sheet of paper and envelope.....	No growth
2. Book, 600 pages.....	No growth
3. Newspaper, 1 pound.....	No growth
4. Newspaper, 2 pounds.....	No growth
5. Blanket	No growth

The anthrax tests in this group of experiments are omitted, as unfortunately the labels of some of the packages were partially obliterated and rendered uncertain.

The following tables, IV., V., VI., VII., VIII., IX., are severe tests, inasmuch as they include packages of paper weighing three pounds. Probably no material presented for disinfection would be as likely to resist the penetration of steam as some of the packages included in these tables.

TABLE IV.—WITH VACUUM.

Temperature 230° F. Time of exposure, 5 minutes.

Plague:—

1. Newspaper, 16 pages.....	No growth
2. Newspaper, 1 pound.....	No growth
3. Newspaper, 2 pounds.....	No growth
4. Book, 600 pages.....	No growth
5. Blanket	No growth

DISINFECTANTS

Diphtheria:—

1. Newspaper	No growth
2. Newspaper, 1 pound.....	No growth
3. Newspaper, 2 pounds.....	No growth
4. Book, 175 pages.....	No growth
5. Blanket	No growth

Anthrax:—

1. Newspaper, 16 pages.....	No growth
2. Newspaper, 1 pound.....	No growth
3. Newspaper, 2 pounds.....	No growth
4. Book, 600 pages.....	No growth
5. Blanket	No growth

TABLE V.—WITH VACUUM.

Temperature 230° F. Time of exposure, 5 minutes.

Plague:—

1. Sheet of paper and envelope.....	No growth
2. Book, 600 pages.....	No growth
3. Newspaper, 1 pound.....	No growth
4. Newspaper, 2 pounds.....	No growth
5. Blanket	No growth

Diphtheria:—

1. Sheet of paper and envelope.....	No growth
2. Book, 250 pages.....	No growth
3. Newspaper, 1 pound.....	No growth
4. Newspaper, 2 pounds.....	No growth
5. Blanket	No growth

TABLE VI.—WITH VACUUM.

Temperature 230° F. Time of exposure, 10 minutes.

Plague:—

1. Disks in book, 600 pages, book tied.....	No growth
2. Disks in single blanket.....	No growth
3. Disks in package of newspapers, 3 pounds	No growth

TABLE VII.—WITH VACUUM.

Temperature 230° F. Time of exposure, 10 minutes.

Plague:—

1. Almanac, 30 pages.....	No growth
2. Magazine, 15 pages.....	No growth
3. Magazine, 150 pages.....	No growth
4. Book, 600 pages.....	No growth
5. Newspaper, 2 pounds.....	No growth

PREVENTION OF INFECTIOUS DISEASES

TABLE VIII.—WITH VACUUM.

Temperature 230° F. Time of exposure, 15 minutes.

Plague:—

1. Sheet of paper and envelope.....	No growth
2. Sheet of paper and envelope.....	No growth
3. Newspaper, 1 pound.....	No growth
4. Newspaper, 2 pounds.....	No growth
5. Mattress (Mexican Moss).....	No growth
6. Mattress (Excelsior).....	No growth
7. Blanket	No growth
8. Coats with disks in pockets.....	No growth

TABLE IX.—WITH VACUUM.

Temperature 230° F. Time of exposure, 15 minutes.

Plague:—

1. Newspaper, 2 pounds.....	No growth
2. Newspaper, 3 pounds.....	No growth
3. Blanket	No growth

Diphtheria:—

1. Newspaper, 2 pounds.....	No growth
2. Newspaper, 3 pounds.....	No growth
3. Blanket	No growth

Anthrax:—

1. Newspaper, 2 pounds.....	No growth
2. Newspaper, 3 pounds.....	No growth
3. Blanket	No growth

Experiments have shown that the above temperature and exposure were destructive to the spores of anthrax placed inside the packages.

The result of the experiments above described leaves practically no doubt that a temperature of 230° F., with an exposure of fifteen minutes in a modern steam disinfecting chamber, can be depended upon to destroy all organ-

DISINFECTANTS

isms which may be present in packages of clothing, bedding and other textile fabrics which may be presented for disinfection.

In the tests made with low temperatures there was no steam pressure in the chamber, and, as might be inferred, the penetration was ineffective. If this result occurs in a tight chamber, much less can it be expected that any satisfactory result will follow the introduction of steam into a living-apartment, or in the hold of a vessel, although the latter has been advocated. It would be impossible to secure or maintain a steam pressure in a living apartment or hold of a ship sufficient to insure the disinfection of their contents. Vessels with iron hulls are now being substituted for those of wood. Iron hulls are good conductors and are always cold, due to the comparatively low temperature of the water in which they rest. This alone would seriously interfere if not prevent the maintenance of a proper degree of heat. Therefore, the use of steam as a means of disinfecting a vessel's cargo before its removal is practically worthless, moreover many packages which form the vessel's cargo are in cases or covering which steam will not penetrate, such as wooden boxes, etc.

PREVENTION OF INFECTIOUS DISEASES

As a rule such materials as clothing, bedding, etc., are not injured by steam, whereas articles composed in part or entirely of leather or wood, paintings, books with stiff covers, glued material, etc., are destroyed or badly injured by this agent, and delicate fabrics, such as satins and velvets are usually more or less damaged; therefore, those whose effects are to be treated with steam should always be fully informed regarding its action, not only to prevent the destruction of property but also to avoid damage suits, which not infrequently result when goods are sent to public disinfecting stations for treatment. For various reasons it is important that each package forwarded for disinfection should be inspected, if its contents are not definitely known, before it is placed in the steam chamber, for, even after careful instructions are given, articles which are known to be destroyed or injured by steam are sometimes placed inside of packages prepared for disinfection.

Contrary to the general belief, mail can be disinfected with modern steam apparatus without injuring it, or defacing the superscription, etc., if care is used to prevent the different articles from adhering. This can be done by,

DISINFECTANTS

improvising a sufficient number of trays or shelves covered with sheets upon which the letters are spread out. It is only by this method that the disinfection of mail can be accomplished, as gaseous disinfectants cannot be depended upon for this purpose. As a matter of fact, there is no reliable or scientific evidence that the disinfection of mail is called for, therefore it should be omitted unless there is some specific reason for it.

In the operation of a steam disinfecting chamber means should be taken to prevent injury to the material under treatment resulting from the condensation of the steam on the upper and inner part of the chamber; as the dripping commonly contains oxide of iron, and may cause discoloration or staining of the textile fabrics with which it comes in contact. This may be prevented by constructing a galvanized sheet-iron hood over and some distance above the car, and extending beyond its ends and sides.

As already stated, it is very desirable that the car should be made of heavy galvanized iron netting set in an iron frame. In this way its contents are kept in place and not allowed to bulge out against the inner side of the chamber, as often occurred in cars of the old pattern,

PREVENTION OF INFECTIOUS DISEASES

which contained shelves with no side protection.

BOILING WATER

Boiling water if properly employed is the most valuable and practical general disinfectant. Its range of usefulness is very great. It costs nothing, acts promptly, and is safe and can be made available at almost any time and place.

Material to be disinfected by boiling water must be subjected to it continuously for a period of fifteen minutes, and during this time the water must constantly boil. The simple placing of articles in boiling water which is allowed at once to cool does not insure disinfection.

Boiling water is particularly valuable for the disinfection of discharges, for there is no other agent which can so surely be depended upon for this purpose. It is also valuable for the disinfection of bed linen and cotton goods, glassware, cutlery, etc. Woolen goods should be excepted if there are other means of treatment available as this material usually becomes shrunken when subjected to the action of this agent. A simple and inexpensive gas, oil or

DISINFECTANTS

coal stove may be used to boil the water, and some sort of receptacle to hold it can always be found or improvised in the household.

For the disinfection of intestinal discharges the receptacle to contain the water should be made sufficiently large to receive the bed-pan and its contents in order that both may be disinfected at the same time—a very important detail, as it is the handling and attempted disinfection of the bed-pan after the discharge is thrown out which is undoubtedly a source of infection through the nurse or attendant. A receptacle of this kind also furnishes means for disinfection of other presumably infected material. The addition of a small amount of permanganate of potassium or the combination of lime and copper, which will later be referred to, will usually prevent any unpleasant odor that may arise during disinfection. The steam which escapes from the apparatus may in some simple way be conducted to the outside of the apartment. The apparatus employed at the New York Quarantine Hospital, at Swinburne Island, consists of copper receptacles which hold six bed-pans for disinfection. They are heated by gas, are sewer connected, and from the top

PREVENTION OF INFECTIOUS DISEASES

of each is a spout connected with a flexible tube which conducts the steam out of the window or some other opening. The bed-pan with its contents just as it is taken from the patient is placed in this receptacle and left for 15 minutes while the water is boiling. This apparatus is very practical and offers a sure, safe and simple method of disinfecting discharges and cleaning the receptacles before they are removed from the apparatus and replaces the inefficient and complicated means which are commonly employed for this purpose. A smaller and simpler apparatus of this character either in the sick room or one adjoining makes it convenient and practicable to promptly disinfect all discharges from the patient, dressings and other textile fabrics, and meets the most important requirement where an infectious disease is under treatment, i. e., the prompt disinfection of discharges.

DRY HEAT

Dry heat is of little practical value in general disinfection. Its power of penetration is limited, and the temperature necessary to secure, for instance, the disinfection of clothing, bedding, etc., even in small packages, commonly

DISINFECTANTS

results in the destruction or injury of these materials. The use of dry heat as a disinfectant is at present rather limited to laboratory work.

There can be no doubt of the superiority of heat, particularly steam and boiling water, over all other disinfectants in dealing with infectious diseases. Although steam is best for the disinfection of clothing, bedding, etc., particularly in public disinfection, boiling water is more valuable as a disinfectant because it is always available, its use involves no special apparatus, and, most important of all, it can be used in the treatment of infected discharges and material in the sick room at all times during the progress of the disease, a most important provision. While it is required that the bedding and other articles used by the patient shall be treated, it is of far greater importance that the discharges be disinfected as soon as they are removed from the patient, inasmuch as in certain infectious diseases they constitute the only medium of infection. For the disinfection of this material no other agent equals heat in the certainty of its action as a germicide; unfortunately the superiority of

PREVENTION OF INFECTIOUS DISEASES

boiling water for this purpose is not yet appreciated. However, its indisputable power as a disinfectant, availability and practicability will sooner or later insure its employment to the exclusion of other disinfectants in the sick room.

SULPHUR DIOXIDE

The belief has long existed that the exposure of presumably infected articles to burning sulphur is an important factor in limiting or preventing outbreaks of infectious diseases. Without doubt sulphur dioxide deserves the credit of being the oldest known gaseous disinfectant. While apparently satisfactory results in the prevention of infectious diseases may have been responsible for its early reputation, it is probable that its popularity at that period was founded largely on its extremely irritating qualities, for the most offensive and objectionable agents were at one time supposed to offer the greatest protection.

Sulphur is a mineral substance found in various parts of the world, the principal supply being obtained in Sicily. In preparing it for commerce the ore is placed in large stone receptacles, heat being applied at the top of the mass, at which point sulphur dioxide is gen-

DISINFECTANTS

erated. The lower part is simply softened and runs into molds forming the ordinary sulphur of commerce.

Properly speaking, it is the sulphurous acid formed by the combination of sulphur dioxide and the moisture of the air which disinfects.

Sulphur dioxide at the best can only be employed for superficial disinfection, and should never be depended upon to penetrate. The full combustion of four pounds of sulphur for every one thousand cubic feet of space contained in the apartment under treatment, with an exposure of six hours, will probably secure the full disinfecting power of this agent if the apartment is well sealed, and provided always that sufficient moisture is present. Various estimates have been made as to the amount of moisture which is necessary for this purpose; theoretically, it is held that the volatilization of one pint of water at the time of the combustion of four pounds of sulphur is the amount required to secure the germicidal effect of the latter. The author's investigation does not confirm this statement, as experiments show that many times this amount of moisture cannot always be depended upon to secure the required result. The investigation referred to included the use of ad-

PREVENTION OF INFECTIOUS DISEASES

ditional moisture in different quantities both before and at the time of the combustion of the sulphur; also experiments with different degrees of humidity at various seasons of the year, etc. The results obtained clearly indicate that from a practical standpoint sulphur dioxide cannot be depended upon even for superficial disinfection unless sufficient moisture is present; even then it is difficult to estimate how much added moisture is necessary to insure the full germicidal value of sulphur dioxide inasmuch as the humidity which may exist at the time has a very important bearing on the subject. It may be said, however, that the evaporation of two quarts of water for each four pounds of sulphur at the time of its combustion will probably secure the full disinfecting value of this agent without regard to the humidity present. An attempt to estimate in each act of disinfection the atmospheric condition, etc., as a means of determining the amount of moisture to be added renders the latter method, particularly in public work, very impracticable. It may be said in a general way that in the summer, particularly when the humidity is high, the question of added moisture need not be considered, whereas later in the year, when apart-

DISINFECTANTS

ments are closed and heated, the evaporation of the amount of water above referred to should be carried out. This may be done preferably by boiling the water in a superficial metal receptacle over the burning sulphur about six inches above the flame.

It should be remembered that sulphur dioxide will bleach or otherwise injure colored fabrics, gilded material, certain wall-papers, silks, satins, etc., and is, therefore, objectionable for use where these articles are present.

It may be said in favor of this agent that the sulphur used in the generation of the gas is easily obtained and quite cheap, costing not more than three or four cents per pound; and an apparatus for its combustion may be improvised with but little or no expense as follows: Two or three bricks are laid on the bottom of an ordinary wash-tub; on these is placed a tin pan or some metallic receptacle for the sulphur. Water should be poured into the tub at a height just above the bricks and covering the bottom of the pan. This arrangement prevents danger from fire, which might occur if the pan containing the burning sulphur rested directly on the floor, and also protects the bottom of the pan. Apparatus for the gen-

PREVENTION OF INFECTIOUS DISEASES

eration of sulphur dioxide for general disinfection usually follows the principle embodied in this simple arrangement.

In order to secure so far as possible the complete combustion of the sulphur used for this purpose, it must be broken in small pieces, over which alcohol should be freely applied—methyl alcohol, which is quite cheap, will answer the purpose. After the alcohol has been added, it may be ignited by a taper or by a lighted match dropped on the broken sulphur. When thus treated there is almost complete combustion of the sulphur, which does not occur if the latter remains in large pieces or when an attempt is made to ignite it by a live coal—an old and unsatisfactory method. Powdered sulphur should not be used, as thorough combustion does not take place owing to a deficiency of air in the mass.

Sulphur dioxide is quickly destructive to vermin, insects, etc., at any time and without regard to moisture, and in much smaller quantities than is required in disinfection. The full combustion of one pound of sulphur for every one thousand cubic feet of space is sufficient to kill rats in thirty minutes. Recent experimental work at the New York Quarantine Labora-

DISINFECTANTS

tory has shown that the burning of even one-half pound of sulphur in an apartment of one thousand cubic feet of space will secure this result—sulphur dioxide is also destructive to mosquitoes and to other insects and it is probably the best agent available for this purpose. A knowledge of this fact is very important in dealing with outbreaks of plague and yellow fever.

FORMALDEHYDE

Formaldehyde gas was accidentally discovered in 1868, by Professor A. W. Hoffman, a German chemist, who found that in heating a platinum spiral over the flame of an ordinary laboratory lamp burning methyl or wood alcohol this gas was produced. Subsequently, Trillat, a French investigator, observed that a small amount of formaldehyde added to urine prevented or retarded decomposition. Trillat, in 1892, after careful experimental work, presented to the French Academy of Sciences the result of his research regarding the germicidal properties of this agent. Since that time formaldehyde has probably received more careful and thorough investigation than any other disinfectant in use.

PREVENTION OF INFECTIOUS DISEASES

In commerce, formaldehyde gas is produced by the imperfect combustion of wood or methyl alcohol. It is colorless, has a pungent odor, and is extremely irritating to the respiratory tract of man and animal; however, although it is not respirable in the human being, it cannot be depended upon to kill vermin, insects, etc.

A lamp devised by Prof. F. C. Robinson, Professor of Chemistry of Bowdoin College, illustrates the principle upon which formaldehyde is produced. The lamp referred to is constructed as follows: An upright shaft supports at its upper part a reservoir for methyl alcohol which reaches, through a small tube, a pan placed at the lower part of the apparatus. The pan, which is about eight inches in diameter, and two inches deep, is covered by a cylinder about ten inches high, its upper two or three inches, being made cone-shaped with an opening of three inches at the top for the discharge of the gas. Placed about midway in the cylinder is a diaphragm, consisting of a perforated platinized asbestos disk. Numerous small openings exist in the cylinder for the admission of air to maintain combustion. In preparing the lamp for use the alcohol is

DISINFECTANTS

allowed to run into the pan to a height just above the opening of the tube from the reservoir, which enters near the floor of the pan. The alcohol is then ignited, preferably by a lighted taper, and the cover or cylinder placed in position over the pan. It is retained in this position but a few minutes, sufficiently long to heat to redness the asbestos disk. The cylinder is then lifted and a tight metallic cover immediately placed over the pan to extinguish the flame, and then quickly removed and the cylinder again placed over the pan. The heat from the red-hot disk vaporizes the alcohol, and the oxidation follows, formaldehyde gas being produced and discharged through the opening on top of the cylinder.

Formaldehyde solution is a twenty to forty per cent solution of formaldehyde gas in water, and is the agent from which this gas is obtained for disinfection. It is prepared for commerce by generating the gas on a large scale on the principle already referred to in connection with the Robinson lamp; this is then conducted to tanks containing water. Therefore, in disinfection the formaldehyde gas is simply released from the latter.

The different apparatus or methods which

PREVENTION OF INFECTIOUS DISEASES

have been or are now employed in formaldehyde gas disinfection are as follows:

1. The exposure of the solution in superficial pans.

2. Sheets soaked in the solution and spread out on lines.

3. The heating of pastels of paraformaldehyde or solid formaldehyde.

4. The generation of formaldehyde gas by the imperfect combustion of wood alcohol. (See description of the Robinson lamp.)

5. The use of an apparatus known as an autoclave or regenerator. This method of generating formaldehyde gas was suggested by Trillat, who found that by adding to formaldehyde solution a 10 to 30 per cent solution of a neutral salt, preferably chloride of calcium, and placing the mixture in a closed receptacle and applying heat, the gas contained was rapidly driven off without the formation of paraformaldehyde. The Trillat apparatus prepared for this purpose consists of a copper cylinder or receptacle sufficiently strong to stand a pressure of forty or fifty pounds, and silvered on the inside to prevent chemical action of the formaldehyde on the copper. The cylinder ordinarily used has a capacity of three or four quarts and rests on

DISINFECTANTS

a frame having a space underneath for a lamp to generate the necessary heat. The top of the receptacle, which can be entirely removed, is fastened to the apparatus by turn buckles. It is supplied with a pressure gauge, and has an escape pipe of about 1-16 of an inch inside diameter, which transmits the gas from the cylinder through a key-hole or other opening into the apartment to be disinfected. In preparing the apparatus for use, the mixture above referred to is poured into the receptacle, the cover tightly clamped, the lamp underneath lighted, and the valve of the escape pipe closed until a temperature of 135° C. is reached. At this point there is an inside pressure of about thirty pounds; the valve is then opened and the gas allowed to escape. The gas from one pint of formaldehyde solution, which is believed to be sufficient for superficial disinfection of a room of one thousand cubic feet of space, will be discharged in about thirty minutes. The appearance of the Trillat apparatus a number of years ago was followed by the construction of a variety of apparatus of somewhat similar character, the main difference being that while the Trillat apparatus was made to stand pressure, the later ones were made to gen-

PREVENTION OF INFECTIOUS DISEASES

erate and discharge the gas without pressure—a very important and necessary improvement inasmuch as the danger from explosion is prevented. The cylinders of the later apparatus are made usually of thin copper, the gas being discharged in the form of vapor. These apparatus are supplied with a lamp underneath, which generates the heat in the same manner as the Trillat apparatus; the gas is discharged through a conducting tube, which passes through the key-hole or other opening into the apartment. They are practically safe, weigh less, and are, therefore, more portable than the Trillat type.

6. A very simple and effective means of generating formaldehyde has recently been suggested by Mr. Henry V. Walker, formerly an Inspector of the New York Department of Health, and is as follows:

For the disinfection of an apartment containing one thousand cubic feet:

Saturated solution of aluminum sulphate...	2 ounces
40% Formaldehyde solution	6 ounces

These are to be mixed and poured over one pound of unslaked lime contained in a metallic receptacle such as an ordinary tin pan. The formaldehyde gas which is evolved by this mix-

DISINFECTANTS

ture is discharged in about fifteen minutes. Great care must be taken in selecting the lime, which as a test should slack rapidly in cold water. It should be broken into small pieces in order to secure prompt results. If air-slaked lime is used the process is of little or no value.

A stock solution may be made by dissolving twenty to twenty-five pounds of commercial aluminum sulphate in five gallons of hot water and mixing this solution with fifteen gallons of a forty per cent formaldehyde solution. Eight fluid ounces of this mixture added to one pound of lime are to be used for every one thousand cubic feet. The chemistry of this action is referred to by Mr. Walker as follows:

“The method of generating formaldehyde gas from its aqueous solution consists in utilizing the property of lime of combining with water, and thus to remove the solvent and liberate the gas. The addition of lime to aqueous formaldehyde, however, is not an efficient means of generating formaldehyde gas for two reasons:

“(1) The mere ebullition of such a solution does not suffice to expel the gas.

“(2) The calcium hydroxide reacts with aqueous formaldehyde forming carbohydrates

PREVENTION OF INFECTIOUS DISEASES

as akrose, formose, and their decomposition product, methylenitan.

“The first of these difficulties is avoided in the process about to be described by using a sufficient quantity of lime to combine with all the water contained in the formaldehyde solution. The lime is used, not as a calorific body, but as a dehydrating agent.

“The second difficulty mentioned is overcome by the addition of a substance such as sulphuric acid or aluminum sulphate, which reacts with lime to form an insoluble compound. It has been found, as was to be anticipated, that the reaction between calcium hydroxide and formaldehyde is dependent upon the hydroxide being present in solution, thus facilitating molecular contact and chemical reaction. The bodies mentioned (sulphuric acid, sulphate of alumina, etc.) by keeping the reacting mixture free from calcium hydroxide in solution, prevent condensation of the formaldehyde.

“When sulphuric acid is used, the fumigating liquid is made by adding to the commercial 40 per cent formaldehyde solution, about one-third of its volume of commercial sulphuric acid. Eight ounces of this mixture, with one

DISINFECTANTS

pound of lime, are required for each one thousand cubic feet of the apartment to be fumigated.

“A serious objection to the sulphuric acid mixture is that, upon standing, the formaldehyde is converted into solid polymerized formaldehyde (paraform), which separates out in the form of a deposit closely adherent to the bottle. The use of this mixture has therefore been abandoned in favor of a mixture containing aluminum sulphate instead of sulphuric acid as this mixture does not deposit paraform.”

7. An effective and simple method of generating formaldehyde gas is by the permanganate process, as follows:

For an apartment of one thousand cubic feet of space, 13 ounces of permanganate of potassium are added to two pints of a 40 per cent formaldehyde solution. Great care must be taken in preparing this mixture, which must be made in a large metallic pail to prevent escape of the excessive foaming or overflow which occurs. The permanganate should first be placed in the pail and the formalin poured in afterwards. The gas is generated at once, and for this reason arrangements must be made beforehand

PREVENTION OF INFECTIOUS DISEASES

to leave the apartment quickly. While this is a rapid and effective means of generating the gas, there are certain results which may occur that must be carefully considered before this method is employed. The violent chemical reaction that takes place when the mixture is made is apt to cause combustion, and the resulting flame may rise some distance above the receptacle, and cause fire if an inflammable article is in the immediate vicinity. Furthermore, when this occurs the formaldehyde gas is rendered useless and no disinfection occurs. The gas burns with a pale blue flame, and is hardly noticeable during the day time, but is apparent in the dark. If no flame occurs it may be assumed that the gas is intact.

In weighing the value of the different methods of disinfection with formaldehyde gas, the following must be carefully considered: In order to secure the full effect of this agent as well as other gaseous disinfectants, particularly in the apartments which cannot be made reasonably tight, it is necessary that it be introduced rapidly and in as large a volume as possible in order to obtain its full germicidal effect. The use of apparatus for the direct generation of formaldehyde gas (such as the

DISINFECTANTS

Robinson lamp) requires that the process shall take place within the closed apartment and as a rule out of sight. Owing to some defect or lack of preparation, combustion may not always take place, or it may cease shortly after the apartment is closed and no disinfection occurs; again, this method is attended with some danger by causing fire, particularly if the disinfection is performed on shipboard, where the position of the apparatus is liable to be moved; besides, the process is altogether too slow.

The release of gas from a formaldehyde solution contained in pans cannot be depended upon as the gas is given off slowly and irregularly; moreover, in pans a large amount of the gas assumes a solid form (paraformaldehyde), which appears as a white substance along the edges of these receptacles and has no practical value as a disinfectant until heated; neither can sheets soaked in formaldehyde solution be depended upon for this purpose. The latter method of securing the gas is extremely irritating to the respiratory tracts of those in charge of the disinfection. The burning of tablets of paraformaldehyde is likewise open to some of the objections just referred to,

PREVENTION OF INFECTIOUS DISEASES

viz., the process is slow and carried out in closed apartments where it cannot be watched.

While the use of the autoclave, which rapidly abstracts the gas from the formaldehyde solution and allows it to pass through the key-hole of the door or other opening into the apartment to be treated, does away with most of the objections already referred to, it is a more or less complicated and somewhat expensive apparatus, which is not always procurable in small communities.

The Walker method is simple, safe and inexpensive and if properly performed acts promptly. However, difficulty not infrequently arises in securing unslaked lime of the proper kind; without this, failure will follow its use. To obviate this, Mr. Walker has placed on the market a lime particularly prepared for this purpose, as well as a mixture of aluminum sulphate and formaldehyde solution for immediate use. The objection to this lies in the fact that the formula is a secret one and the material cannot at all times be secured.

The generation of formaldehyde by the permanganate method is rapid and effective, the ingredients can easily be procured, and a receptacle for mixing them can be found any-

DISINFECTANTS

where with but little or no expense. However, it is not without some danger, and at times may be rendered valueless for the reasons already referred to.

Everything considered, the permanganate and Walker methods may be regarded as the most effective and practical means employed at the present time for the generation of formaldehyde gas for the purpose of disinfection.

The value of formaldehyde gas has been variously estimated by writers. It would not be unfair to say that it ranks with sulphur dioxide as a general superficial disinfectant. Its advantages are that added moisture is probably not required to secure the full germicidal effect of this agent, and it does not destroy or injure the textile fabrics, hangings, gilt, etc., which are exposed to it as sulphur dioxide will do. On the other hand, formaldehyde gas cannot be depended upon to kill vermin and insects, which quickly succumb to sulphur dioxide.

Reliable proof is constantly accumulating to show that disinfection of a room after the recovery of a case of infectious disease is not usually necessary, particularly if proper sani-

PREVENTION OF INFECTIOUS DISEASES

tary measures have been carried out during the course of the disease. Even though it were necessary, the methods of room disinfection with gaseous agents as usually performed are oftentimes practically useless. In the future cleanliness, prompt destruction of discharges and other infected materials will unquestionably to a great extent take the place of room disinfection at the termination of the case.

OZONE

Ozone, a modification of oxygen, has until the past few years been treated rather as a curiosity; lately, however, it has been subjected to careful scientific investigation, particularly in connection with the purification of water. Although ozone may be produced chemically, the means by which it is secured for commercial use or scientific investigation is electricity.

The value of ozone for the purification of potable water is unquestioned; however, the cost of its production at the present time practically prohibits its being used for this purpose.

The author's investigation of this agent

DISINFECTANTS

demonstrated that ozone in a sufficient concentration and under certain conditions in an experimental apartment of one thousand cubic feet of space killed bacteria which were directly exposed. The concentration sufficient for this purpose does not admit of respiration in the human being, and rats placed in the room during the experiments were killed within one hour. Ozone equals sulphur dioxide in the bleaching and destruction of certain fabrics and articles. It may be added that in the experiments already referred to, ozone showed no evidence of greater penetration than sulphur dioxide or formaldehyde.

At present the great cost of the apparatus required for the production of ozone and the long period required to secure the proper concentration make it of little or no practical value as a general disinfectant.

CHLORINE

While chlorine gas has undoubted disinfecting power, the danger which attends its generation and its use leaves no justification for its employment as a germicidal agent.

PREVENTION OF INFECTIOUS DISEASES

BICHLORIDE OF MERCURY

Mercuric chloride, commonly known as corrosive sublimate, bichloride of mercury, and perchloride of mercury, is obtained for commercial purposes by heating equal parts of dry sodium chloride (common salt) with mercuric sulphate, manganese dioxide being usually added to the mixture as an oxidizing agent to prevent the formation of calomel. Bichloride of mercury is soluble in water, but more so in alcohol and ether. It is soluble in two parts of boiling water and about fourteen parts of water at the room temperature. By dissolving one half pound of the dry salt in a gallon of hot water and allowing the liquid to cool, an almost saturated solution can be obtained.

Bichloride of mercury has a pronounced metallic taste, is without odor, and is a violent poison; the latter constitutes a serious objection to its use in general disinfection. Other objections are its precipitation when in contact with albuminous substances and its tendency to fix blood stains permanently on clothing. The latter may be largely avoided if the spots are washed out before the articles are immersed in the bichloride solution. All of these condi-

DISINFECTANTS

tions emphasize the inferiority of this agent as compared with boiling water or steam. The extremely poisonous quality of bichloride of mercury makes it necessary that every precaution be taken in its use. If a stock solution is kept on hand it should be in a glass receptacle to which a minute quantity of fuchsin or some coloring matter is added for identification, and to prevent mistakes, which are liable to occur if the solution is colorless. The receptacle should have a conspicuous label including the word "Poison," and also formulæ for making solutions of different strength.

In the disinfection of textile fabrics there should be an immersion of one hour in a 1-1,000 solution of this agent.

Bichloride of mercury has but little practical value in the disinfection of bedding and clothing, and is rarely used for this purpose, nor should it be used for the disinfection of discharges, particularly from the intestinal tract, if boiling water is available.

CARBOLIC ACID

Carbolic acid, also known as phenol, phenic acid, phenic alcohol, and benzo phenol, was discovered in coal tar by Runge in 1834. It is ex-

PREVENTION OF INFECTIOUS DISEASES

tracted by means of caustic soda and subjected to a process of purification, after which it is redistilled. Since 1888, it has also been made synthetically from benzol.

Pure carbolic acid is colorless, with a strong characteristic odor, and below a temperature of about 40° C. crystallizes in needles. If traces of tar are present, which usually occur in the commercial product, it turns to a reddish color on exposure. It is soluble in about twenty parts of water in ordinary temperature; therefore, a five per cent solution is the strongest that can be made. Carbolic acid does not actively coagulate albuminous matter, nor does it set stains in clothing like corrosive sublimate. A three per cent solution with an exposure of half an hour should be used for ordinary disinfection. Carbolic acid as well as bichloride of mercury cannot be depended upon for general disinfection, particularly the treatment of discharges, and, like bichloride of mercury, is inferior to boiling water for this purpose.

LIME

Calcium Oxide—Quick Lime—Burned Lime

Lime is an alkaline earth obtained by calcining lime stone, chalk or marble. As it is

DISINFECTANTS

prepared on a large scale from lime stone, which is more or less impure, the commercial article usually contains magnesia, oxide of iron, alumina, alkaline salts, silica and clay, and consists of a hard grayish white mass fusible with difficulty and without odor, and has a strong alkaline reaction with a caustic burning taste. It requires about eight hundred parts of water at ordinary temperature for its solution, and decreases in solubility with rising temperatures. Therefore, a solution of lime saturated in cold water becomes turbid on being heated. Commercial lime is obtained by heating the carbonate of lime (lime stone, chalk or marble) in a kiln to full redness, when carbonic acid gas is expelled, and the lime remains. Oyster shells are sometimes incinerated for the purpose of obtaining lime. However, this product is used principally for the purification of illuminating gas and not for general commercial purposes.

In disinfection great care must be taken to select lime which has not been exposed to the air and known as air-slaked. This has absorbed moisture and carbon dioxide and is rendered practically inert. For instance, the use of air-slaked lime in the production of formaldehyde

PREVENTION OF INFECTIOUS DISEASES

gas according to the Walker process should be particularly avoided.

Theoretically, slaked lime is prepared by mixing about one pint of water with three pounds of lime. In practical work, however, as in the construction of buildings, etc., water is added to the lime until the mass assumes the consistency necessary for the work.

If in slaking lime an excess of water is used a white fluid mixture is the result, known as milk of lime or common white-wash, and usually consists of one pint of slaked lime and eight parts of water by weight.

Cold water takes up only about one-eight-hundredth part of lime, and in this form is known as lime water, a preparation sometimes used for medicinal purposes. If this is not carefully protected from the air, carbonic acid gas is absorbed and the solution rendered practically worthless.

Chlorinated lime or calcium hypochlorite is commonly known as "Chloride of Lime," or bleaching powder, and is a compound resulting from the action of chlorine upon calcium hydroxide. It usually contains about thirty per cent of available chlorine. It was first prepared by Tennant and Knox, of Glasgow, in 1799. It is

DISINFECTANTS

manufactured on a large scale by passing dry chlorine gas over well slaked lime free from dampness, spread out on shelves and arranged in tiers. Recently, however, chloride of lime has become a by-product of several large manufacturing industries, notably, the electrical works at Niagara Falls, which has materially reduced the price of this agent.

Chloride of lime is a whitish powder with a faint odor of chlorine and has a disagreeable, bitter and saline taste. It is soluble in about 20 parts of water, although the commercial product always leaves a slight residue mainly calcium hydroxide. The solution has an alkaline reaction—strong acids liberate the chlorine. Its value is due to the presence of chlorine gas in the proportion above referred to.

Lime has been specially recommended for the disinfection of privy-vaults, discharges, etc. As the contents of the privy-vaults cannot be disinfected by adding lime to the mass, nor can even small amounts of infected discharges be properly penetrated to insure full disinfection, unless thoroughly mixed, it has been shown that the range of usefulness of this agent as a disinfectant is considerably restricted.

When it is deemed advisable to employ lime

PREVENTION OF INFECTIOUS DISEASES

as a disinfectant, it should be used largely in excess of the material treated, particularly if chloride of lime is selected, for in the presence of organic matter this preparation is decomposed and practically rendered inert. It should also be remembered that chloride of lime injures the fabrics with which it is brought in contact. Therefore, the material treated, on its removal from the lime, should be promptly washed out in plain water. Either milk of lime or a mixture of 6 ounces of chloride of lime to a gallon of water may be used for superficial disinfection. The white-washing of walls, ceilings, woodwork, etc., is unquestionably a practical and effective method of disinfecting contaminated free surfaces.

While lime under some conditions is a valuable disinfectant, its reputation and usefulness largely depend on its action as a deodorant, which is exceedingly important, particularly when combined with copper. In reference to this the following is cited from the author's investigation of lime and copper as deodorants:

“In the second series of experiments, i. e., to ascertain the value of the copper as a deodorant, many tests were made with various forms of offensive matter, both fluid and solid,

DISINFECTANTS

including decomposed meat and fish, sewer water containing fecal matter, etc. The same solutions were used as in the experiments made with mosquito larvæ, and the experiments showed that although copper acted as a deodorant it was not so uniformly successful as when it was used in combination with lime. In water, made very offensive by adding organic matter from sewers, or decomposed meat or fish, the pronounced deodorizing qualities of copper and lime were very apparent. Less than half an hour after the addition of these agents there was but little or no odor perceptible. This result was as a rule permanent, and in only a few instances was it necessary to make a second application. The deodorizing and clarifying effect of copper and lime on offensive and turbid water is remarkable, and can only be fully appreciated by those who have witnessed the experiment.

“The effect of the mixture on offensive receptacles and apartments such as pails, barrels, vaults, cesspools, cellars, stables, etc., is pronounced and exceedingly satisfactory. This result also follows the liberal use of the mixture on collections of garbage, etc., where organic matter has been in process of decay for a long

PREVENTION OF INFECTIOUS DISEASES

time and where the odor is very obnoxious. In the use of the mixture in the latter instances it was found that the decomposed organic matter present was in such large quantities that the amount of copper and lime usually employed as a deodorant was not quite sufficient to produce the desired result. In these cases an additional amount of copper was added. However, the formula generally used (one pound of copper, one pound of lime, and ten gallons of water) was as a rule found to be sufficiently strong to deodorize the offensive matter with which it was brought in contact.

“The need of a practical and effective deodorant has long been fully appreciated by sanitarians. A true deodorant is one which destroys offensive odors by neutralizing them, and not by masking them with a stronger odor. But very few good practical deodorants are at our command. The use of the preparation of lime in powder, although commonly employed, is not satisfactory, neither is any deodorant in the form of powder applicable to general use, for the reason it does not insure so complete a mixture with offensive material. The difficulty in securing good results from the use of deodorants in this form is illustrated in

DISINFECTANTS

attempts to deodorize masses of garbage, etc., where only a portion of the material can be treated, as the powder cannot be well applied to all parts of the mass.

“Bromine has until recently been regarded as one of the best practical deodorants in use. However, the employment of this agent is liable to be associated with considerable danger, inasmuch as it so violently irritates the respiratory tract that in making solutions of it for deodorizing it is necessary to break the bottle under water. On the other hand, both copper and lime are practically harmless, and their use is attended with no danger; besides, they are comparatively very cheap—sulphate of copper can be purchased for five cents per pound, and lime for three cents per pound; a ten-gallon solution, therefore, can be made for eight cents. When we consider that a gallon of this mixture will deodorize a considerable mass of decomposed solid matter, it will be appreciated that very little expense is attached to its use. Again, in contrasting bromine with copper and lime, it will be found that in treating decomposed organic matter the effect of the bromine is transient, and frequent applications must be made to prevent the recurrence of offensive odors,

PREVENTION OF INFECTIOUS DISEASES

while a single or at most two applications of the mixture of copper and lime is generally sufficient. This factor alone is of great practical importance.

“Sulphate of copper has a strong affinity for sulphur, forming with it insoluble sulphides. Therefore, the value of this agent as a deodorant is largely due to the fact that offensive odors emanating from decomposed animal and vegetable matter are commonly caused by the formation of sulphur compounds.

“In the use of copper and lime it must be borne in mind that when these agents are mixed together a precipitate takes place. This contains the important deodorizing elements, and it is imperative that the mixture should be constantly stirred when being applied. Care must be taken in selecting the copper and lime, and in preparing the mixture, in order to secure a satisfactory result. Fortunately, sulphate of copper, commonly known as ‘blue vitriol’ is so cheap that it does not invite adulteration; it is sometimes confounded with ‘copperas’ (sulphate of iron). Chemically, the lime used in the preparation is called calcium oxide, but is commonly known as ‘unslaked’ or ‘rock-lime.’ It is purchased either in barrels or in

DISINFECTANTS

tin cans, the latter being preferable as it better insures protection from the air, although if properly covered and protected in barrels or in large receptacles it will be sufficient for the purpose. Lime which has been exposed to the air and is known as 'air-slaked,' is improper for this purpose. The unslaked or rock-lime used in this mixture must not be confounded with chloride of lime. In preparing the mixture which I have recommended as a deodorant, and which is composed of one pound of copper, one pound of lime and ten gallons of water, it is advisable to first dissolve the copper by placing it in a linen bag suspended by a string just below the surface of the water. In this way it is dissolved much more rapidly than when the copper is thrown in the bottom of the receptacle and stirred. For example, the copper may be dissolved in six or eight gallons of water, leaving the remainder of the ten gallons to prepare the lime, which is done by placing the latter dry in the pail or other receptacle and gradually adding water and stirring until the 'steaming' or 'slaking' is completed. The lime is then gradually added to the water in which the copper has already been dissolved, the mixture being constantly

PREVENTION OF INFECTIOUS DISEASES

stirred during this time; a precipitate then takes place. In a tightly-covered receptacle the mixture may be kept indefinitely as a stock solution, always to be well stirred before using.

“In the treatment of the offensive masses, such as decomposed organic matter, garbage heaps, offensive woodwork, vaults, etc., no complicated apparatus is necessary for the application of this mixture. An ordinary garden sprinkling pot, made of tin and of a large size is all that is needed for this purpose. As the mixture is rather thick, it is best to enlarge the small openings in the sprinkler with an awl, or some smooth and round instrument, to allow a freer exit of the deodorant. In treating offensive solutions the sprinkling pot is not needed, as the mixture is simply added in the proportion of about one gallon to thirty or fifty gallons (estimated) of the fluid to be treated. The mixture of the lime and copper will more or less adhere to the various receptacles. However, if it is desired, it can, after a sufficient exposure, be easily removed by a stream of water. In cellars, etc., the mixture may be applied with a white-wash brush, but for offensive woodwork the employment of the

DISINFECTANTS

sprinkling pot is preferable. A severe test for the mixture may be found in stables where the ammoniacal odor is very strong and pungent, particularly where urine-soaked wooden floors exist. The good effect of the mixture in these cases is apparent within an hour after its application. The solution of copper alone, or in combination with lime, so far as my experiments have shown, has no effect upon and does not discolor white linen or cotton goods, although soaked in this mixture for six or eight hours. At the end of forty-eight hours, some slight greenish discolorations in streaks were noticed; these were quickly removed by thorough washing. However, to deodorize material of the kind just referred to, it is only necessary to let it remain in the mixture for a comparatively short period.

“I believe the mixture of copper and lime is the most valuable and practical deodorant we possess at the present time. Its action is rapid and permanent, it is practically harmless, cheap and easily made, and seems to comply with the requirements of a typical deodorant. Furthermore, its range of usefulness is extensive, as it can be employed equally well for deodorizing solids and fluids.”

PREVENTION OF INFECTIOUS DISEASES

A careful analysis of the comparative value of the various recognized disinfectants clearly shows that the gaseous agents are of value only when generated under certain conditions, and the manner in which they have heretofore been employed is frequently of little or no value. Even when generated with proper care they cannot always be depended upon—certainly not to penetrate; as has already been stated, an exhaustive investigation of this subject has shown that the use of gaseous disinfectants for the treatment of apartments where infectious diseases have been confined is not often required, particularly where proper cleanliness and disinfection have been carried on during the progress of the disease.

While bichloride of mercury, carbolic acid, and lime have undoubted germicidal value, their range of usefulness in general disinfection is limited. Bichloride of mercury and carbolic acid are poisonous, and in some places may not easily be obtained. They in no way compare with boiling water either in effectiveness or availability; besides, they cannot be depended upon in the treatment of discharges, which constitutes one of the most important elements of disinfection in the prevention of in-

DISINFECTANTS

fectious diseases. Heat is the natural and logical disinfectant, it combines all the essentials of a practical agent for this purpose and must sooner or later be accepted as such.

CHAPTER XI

DISINFECTION IN CONNECTION WITH APARTMENTS OF THE SICK, ISOLATION AND DISCHARGE OF PATIENT

THE disinfection required in the presence of infectious disease, where proper isolation has been imposed, is ordinarily confined to the apartment of the sick. Even here if proper sanitary measures have been enforced the danger of infection is practically confined to the patient, his discharges, and the material in close contact with him. There is little or no authentic evidence to prove that the woodwork about the room, the furniture, hangings, etc., are factors in transmitting disease; on the other hand, evidence is constantly accumulating to show that they are not usual media of infection. It is true that the carpet or floor, particularly about the patient's bed, may be contaminated with discharges; but, if this occurs, it is the result of gross carelessness for they may easily be protected by some form of covering; besides there should be

proper receptacles for discharges, which constitute the most dangerous factor in the transmission of some infectious diseases.

If an opportunity is afforded to prepare a room for the reception of a case of this character, the removal of all unnecessary furniture, hangings, etc., which are not necessary for the care of the patient, may simplify the final treatment of the apartment and its contents; but, this opportunity does not usually occur, and the transfer of a case to another apartment after the disease has fully presented itself is hardly justified unless it affords greater comfort to the patient in the matter of ventilation, etc. The danger of articles of furniture, hangings, etc., in the apartment of the patient, serving as media of infection is largely theoretical, and, as already stated, is not serious if proper sanitary regulations have been enforced during the isolation of the patient.

The character of the disease under treatment has much to do with the disinfection required. Nevertheless, in all instances heat in the form of boiling water should, if possible, be made available for this purpose, particularly for the disinfection of discharges, which are to be dealt with as soon as they are removed from the pa-

PREVENTION OF INFECTIOUS DISEASES

tient; dressing and other textile fabrics should also be promptly destroyed or disinfected by heat. Thin cheese cloth cut in small pieces and boiled in water containing a little soda to soften the fabric should be used in place of handkerchiefs, etc., and then burned. The bed linen and the garments worn by the patient during his illness should be frequently changed and disinfected.

By this prompt treatment an accumulation of discharges or infected material is avoided—an exceedingly important factor in connection with the treatment of infectious diseases. Care should be taken at the beginning of the disease to protect the mattress with a rubber covering in order that it may not be contaminated with discharges; when this has been properly done there are but few instances where it can be properly regarded as a medium of infection.

So far as disinfection of the person of the patient is concerned, the procedure to be followed likewise depends largely on the character of the disease. In tuberculosis, diphtheria, the pneumonic form of plague, etc., special attention must be given the discharges from the respiratory tract. In cholera, typhoid fever,

etc., the intestinal or alimentary discharges constitute the chief media of infection; too much emphasis cannot be placed upon this.

There is good reason to believe that the danger from desquamation, in measles and scarlet fever, is greatly exaggerated, and also that it may prove to be an unimportant, if not negligible factor in the transmission of these diseases; and further investigation will probably show that the danger of infection is during the early or active stage of the disease through the secretion from the mucous membrane. However, until this is more fully decided, the period of desquamation should receive consideration. This consists in the frequent cleaning and scrubbing of the patient in order to remove the dead skin. Soap and warm water are all that are needed for this purpose; the use of bichloride of mercury or carbolic acid is unwarranted and unnecessary, nor is it required that a person who has recovered from an infectious disease shall be removed from his apartment to another for final bathing or the adjusting of fresh clothing.

The proper care of a case of infectious disease during isolation, which includes the prompt destruction or disinfection of discharges and

PREVENTION OF INFECTIOUS DISEASES

fabrics used by the patient while sick, proper ventilation, etc., leaves but little to be done in the sick room after his recovery and this is confined to the bed clothing, unprotected mattress, etc., and whatever other material has been in close contact with him and which may not have been subjected to disinfection. These articles should, if possible, be treated with steam, if this agent is available for the purpose. If not, the goods may be spread out in the room and exposed to either sulphur dioxide or formaldehyde; however, in this instance if any of them have been contaminated with discharges, particularly the mattress, they should be burned.

Attempts to disinfect a carpet, while on the floor, with gaseous disinfectant are of questionable value, although commonly relied upon. If it is believed to be infected with discharges, it should, if possible, be subjected to steam disinfection. However, if proper care is used in connection with the patient's discharges, and particularly if the floor about the bed is protected as above suggested, the carpet need receive no special attention. The bedstead and the woodwork about it, and other articles handled by the patient, should be thoroughly washed with soap and water. The use of bi-

chloride of mercury or carbolic acid for this purpose is as a rule unnecessary.

Due credit is not usually given to air and sunlight as germicidal agents. While they are slow in action and cannot be depended upon for general disinfection, they render valuable aid, particularly in communities where no other treatment is available. There can be no doubt that prolonged exposure to the air and sunlight will render infected material harmless.

The principle to be carried out on shipboard in the presence of infectious disease, so far as disinfection is concerned, is practically the same as that already referred to; namely, careful isolation, fresh air and cleanliness, and the prompt disinfection of discharges and articles used about the patient which may be regarded as infected.

As the isolation apartment on board of a vessel is usually a temporary or improvised one, the ventilation and cleanliness cannot be so well carried out, and it is probable that more material will require destruction than when disease occurs on land; the ship's furnace offers a proper place for this purpose. If the patient recovers on shipboard, which may occur if the vessel is long in transit, he should be treated

PREVENTION OF INFECTIOUS DISEASES

in the same manner as on land, and an effort should be made to carry out the same rules in the treatment of the apartment where he was isolated. The use of a gaseous disinfectant at sea is more or less unpleasant, if not dangerous, because of its extremely irritating qualities, for it is difficult on shipboard to confine it to any one apartment.

The necessity for the so-called disinfection of an apartment with a gaseous disinfectant at the termination of a case of infectious disease is largely theoretical, and had its origin long before it could have been suggested by any bacteriological research. There is very little scientific evidence to support this theory, and the manner in which it is commonly carried out is practically valueless. Besides it often masks the necessity for strict cleanliness and the prompt destruction of the discharges and material used about the patient during the progress of the disease. While the author has no intention of overlooking any means by which infection may be transmitted, he is of the opinion that room disinfection is not generally required where proper sanitary measures are strictly enforced throughout the course of the disease.

THE SICK

Practically, cargoes of vessels require no disinfection; if, unfortunately, a necessity for this should arise, it must be remembered that a cargo cannot be treated while it remains in the vessel, and for this purpose it must be removed.

It is sometimes found that a person having an infectious disease has visited friends or has been in various apartments, public buildings, etc., and it is commonly believed that these places should be disinfected. This is unnecessary and uncalled for provided no discharges are present; if so they should be carefully removed and destroyed and local disinfection performed.

The disinfection of a school, if practically and scientifically carried out, consists first of all in the free use of soap and water, particularly about the desks, chairs, etc., used by the pupils, also all woodwork which may be reached by the hands should be treated in the same manner. The use of either bichloride of mercury, lime or carbolic acid is unnecessary for this purpose, and the addition of a small amount of one of these agents to the water adds nothing to its value and is simply misleading.

Articles such as drinking cups, pencils, slates,

PREVENTION OF INFECTIOUS DISEASES

etc., which are applied to the mouth, should receive special attention. No more effective or practical disinfectant can be used for this purpose than boiling water, particularly for the treatment of glass, tinware, etc. Even slates with wooden frames may be immersed in this, usually without injury, or, if this is feared, they may be treated with soap and hot water. Pencils which have been used by the patient should be destroyed, as they cannot be disinfected in boiling water inasmuch as the glue in the modern wooden slate pencils becomes softened and they are rendered useless.

It is the author's opinion that books can be disinfected only by steam. However, this method more or less injures or destroys the ordinary cardboard, cloth or leather covers, and is therefore only applicable to the treatment of books with paper covers. Gaseous disinfectants cannot be depended upon for the disinfection of books if this treatment were necessary, notwithstanding statements to the contrary. If there is specific or even reasonable evidence that certain books are contaminated by infected discharges, they should be burned if they cannot be treated with steam; but this treatment need not be extended to other books in the same

THE SICK

school or apartment. A great deal has been said and written about the necessity for the general disinfection of books in libraries, etc. Although books in some rare instances may possibly transmit disease, there is no reason to believe that in a general way they constitute a medium of infection, and there is no necessity or justification for the attempts which are sometimes made to periodically disinfect them under these conditions, first, because it is unnecessary, and second, because it would be practically impossible to successfully carry out this treatment. Therefore, the disinfection of books should be restricted to specific instances where there may be sufficient evidence to justify this procedure.

CHAPTER XII

THE THERMOMETER

THE fact that satisfactory scientific evidence has been presented to show that persons rather than things transmit disease, and that the clothing of well persons, baggage, cargoes of vessels, etc., do not act as a medium of infection except in rare instances, demands a rigid inspection of all persons who have been exposed to infection or those who may have come from infected districts, to detect irregular or unrecognized cases which are largely responsible for outbreaks of infectious disease, and which are not detected by an ordinary visual inspection. Furthermore, the statements made by persons held for observation or those arriving from infected areas regarding their health cannot be depended upon in lieu of a careful and thorough examination. It is for these reasons that the clinical thermometer has become a very important factor in the modern inspection of suspects or persons held for obser-

THE THERMOMETER

vation. Many persons passing through the period of invasion of infectious disease are not aware of it, particularly in mild cases. Sailors and others who are subject to hardship and exposure pay little or no attention to mild symptoms, and a visual examination does not usually detect cases of this character. In the quarantine service it is not unusual to find on incoming vessels persons passing through the stage of invasion of yellow fever or some other infectious disease who do not present suspicious symptoms on a visual examination. One of the most effective agents in detecting these cases is the thermometer. This instrument has been constantly employed in the examination of certain persons arriving at the New York Quarantine Station for the past fourteen years, and is regarded as an exceedingly important part of an official examination. Its value, however, depends almost entirely upon the character of the thermometers employed and the means by which they are used.

As an aid in the detection of disease it is sufficient that the thermometer be used in the mouth but not in the axilla. In any event it is unnecessary and impracticable to take rectal temperatures for this purpose.

PREVENTION OF INFECTIOUS DISEASES

Public health officers, particularly those connected with the quarantine service, should always be supplied with a large number of properly tested thermometers in order that emergencies may be promptly dealt with.

The method employed at the New York Quarantine Station in the use of the thermometer is practically as follows. If the temperatures of a large number of persons are to be taken, a well lighted apartment is selected which will permit the proper entrance and exit of those under inspection. A table is required to hold the articles and material necessary for this work, which consist of a passenger or crew list, soap and water, bowls and towels. A sufficient number of stewards or stewardesses are detailed to aid the quarantine officer and his assistants. Besides, interpreters are always necessary to explain to the passengers or crew the use of thermometers, to assure them its use is largely for the purpose of effecting their early release, etc., and to instruct them as to the necessity for keeping their lips closed and to caution them not to break the thermometer with their teeth. Unfortunately the latter is of common occurrence among steerage passengers. One medical officer should not at-

THE THERMOMETER

tempt to deal with a group of more than fifteen or twenty persons at one time. When ready the thermometers are carefully placed in the mouths of those under observation by the medical officer, who, with an assistant, keeps the group under constant observation in order that the proper registration of the thermometer is not interfered with—an exceedingly important consideration. The thermometers should be removed one by one and the degree which the instrument indicates set opposite the name of the person examined. Those whose temperatures are sufficiently high to call for detention should be removed from the rest and placed together in a group under guard. In this manner work is continued until the temperatures of all are taken. Only soap and water need be used in cleaning the thermometers. This quickly accomplishes the desired result and is far more practical and better than dipping them in a solution of carbolic acid or some other disinfectant which does not clean them, and for the short time they are exposed to the solution does not disinfect them. Only tepid, not *hot* water should be employed, otherwise the thermometers may be broken or the mercury carried to a high degree, and driven

PREVENTION OF INFECTIOUS DISEASES

back to the normal point only with difficulty. For this as well as other reasons *every thermometer should be examined immediately before it is placed in the mouth of the person under observation; no exception should be made to this rule.* In the use of the thermometer, particularly among saloon passengers, there is a natural repugnance towards the introduction into the mouth of these instruments which are in general use, and it is only fair that every demonstration of cleanliness should be made before them. A neatly arranged table supplied with clean linen, soap and water in full view, and the thermometers cleaned in their presence, go far to satisfy those whose temperatures are to be taken that everything has been done to insure cleanliness.

In the use of the thermometer it is necessary to know at least approximately the minimum degree of temperature which indicates an abnormal physical condition of a person and justifies his detention for further observation. Many thousand temperatures are annually taken at the New York Quarantine Station. In addition, surgeons of vessels incoming from infected ports are at times requested to take the temperatures of passengers while in transit

THE THERMOMETER

and submit a report of the same on the arrival at the above place.

In the New York Medical Record of November 1, 1902, the author reported a series of experiments, the object of which was to secure the needed practical information in regard to this subject. The persons whose temperatures were examined, arrived at the New York Quarantine Station in apparently good health, and consisted principally of steerage passengers; the thermometers were used under practically the same conditions and by the same medical officers.

In Test No. 1, 16,152 temperatures were taken with carefully registered thermometers, with a maximum exposure, and with careful attention paid to all details necessary to secure the correct results.

TEST NO. I.

582	were between 96°	and 97° F.
1,124	were between 97°	and 98° F.
2,108	were	98° F.
779	were	98.2° F.
7,340	were between 98.4°	and 98.6° F.
2,432	were	99° F.
976	were	99.2° F.
811	were	99.4° F.

While this test practically confirms the belief that the normal temperature of the body

PREVENTION OF INFECTIOUS DISEASES

is about 98.5° F., it also shows that considerable variation from this register may exist in the healthy subject, the variations being largely due to the time of day; the lower temperatures were uniformly found in the morning.

In Test No. 2, the temperatures of eight men connected with the New York Quarantine Station were taken for twelve days at three different periods of the day; between 5 and 7 A. M., 2 and 3 P. M., and 8 and 9 P. M. In all there were 279 temperatures registered with the following result:

TEST NO. 2.

58	were	between	96°	and	97°	F.
67	were	between	97°	and	98°	F.
46	were	98°	F.		
92	were	between	98°	and	99°	F.
11	were	99°	F.		
5	were	between	99°	and	99.5°	F.

The low temperatures indicated in Test No. 2 were as a rule found during the early morning hours, between 5 and 7 A. M., and the higher temperatures later in the day. Two of the eight men involved in this test were firemen, whose duties required them a part of the time, at least, to be exposed to high temperatures in the fire-room of the vessel. However, there was practically no difference between the tem-

THE THERMOMETER

peratures of these men and others who were employed on deck. This test was afterward repeated many times among firemen and stokers of incoming vessels with the same result. Therefore, extended exposure to even high temperature does not as a rule raise the body temperature as its equilibrium is maintained by sweating. However, in prolonged exposure to intense heat a rapid and high elevation of the body temperature with serious results may occur. This indicates a point beyond which nature is unable to preserve the equilibrium.

The full appreciation of this is very important, particularly in quarantine work, as the elevation of a temperature of a fireman or cook on board a steamship is usually promptly declared to be due to his vocation. The investigation above referred to does not confirm this. As an illustration the following may be cited: Among the persons whose temperatures were taken on board an incoming steamship from a yellow fever infected port some years ago was the second cook of the vessel. His temperature was found to be $101\frac{1}{2}$; he was at work in the galley and stated that he felt well. He was considerably disconcerted when told

PREVENTION OF INFECTIOUS DISEASES

that he must go to quarantine for observation and insisted that his increased temperature was due to his work; this was strongly endorsed by the master of the vessel. On the arrival at the detention station he admitted that he had not felt well for two or three days. He was subsequently removed to the hospital and died of yellow fever three days afterwards. Cases of this kind not infrequently occur.

In comparing Tables No. 1 and 2, it will be seen that by far the greater number of temperatures in both tables were between 98 and 99° F., or more correctly speaking, about 98.5° F. However, there is a marked difference in the percentage of high and low temperatures in Tests No. 1 and 2. For instance, in Test 2, which gives the temperatures of eight employés of the Quarantine Station, about 20 per cent of the registers are between 96 and 97° F., whereas, in Table No. 1, this low register (96-97) represents only about 4 per cent of the total number (16,152). This is due to the fact that one-third of the temperatures in Test No. 2 were taken very early in the morning, at which time low temperatures are common, while the temperatures of the steerage passengers in Test No. 1 were taken as a rule not before

THE THERMOMETER

10 A.M. On the other hand, in Table No. 1, it is found that over 25 per cent of the temperatures (4,219) were from 99 to 99.5° F., whereas, in Table No. 2, there is less than 5 per cent within this register (99 to 99.5° F). The large number of temperatures above 99.5° F. found among the steerage passengers, referred to in Test No. 1, was probably due to temporary excitement incident to their detention. This factor was not present among those whose temperatures are recorded in Test No. 2. This is practically confirmed by the fact that 8 or 10 hours after the inspection the temperatures of a large number of passengers included in Test No. 1 became normal again.

The result of this investigation shows the following facts: (1) That the normal temperature in health is about 98.5° F., although subject to considerable temporary variation without denoting an abnormal condition; (2) That a temperature below 98° F. is much more frequent in healthy persons than is generally supposed, and that this low temperature is usually found very early in the morning; (3) That a temperature of 99° F., and even above, is frequently found in the normal condition, although it is, as a rule, probably transient and due to

PREVENTION OF INFECTIOUS DISEASES

excitement or some other temporary cause, and does not indicate an abnormal condition.

It is practically impossible to decide upon the degree of temperature which should call for the detention of suspected persons. When the clinical thermometer was first used at the New York Quarantine as a part of the examination of passengers and crews of incoming vessels, those whose temperatures were above 99° F. were frequently detained, but it soon became evident that this slight elevation was commonly found in well persons. Many persons in normal condition may from slight temporary cause show even a temperature of 100° F., which will quickly return to the normal register. However, the cause of this cannot usually be made clear, and this temperature (100°) should be regarded with suspicion. It is fair to decide that all persons under suspicion whose temperatures exceed 99.5° F. should be detained for further observation. If this temperature is due to some simple temporary cause, it will require only a short detention to prove it, and therefore will not seriously interfere with passengers and crews in transit.

In the use of the thermometer in public health work as a means of detecting disease,

THE THERMOMETER

great care must be taken to guard against successful efforts on the part of those under observation to defeat the end in view. Where it is known that the thermometers are to be used, it is not uncommon for persons to place ice in their mouths and to employ other means to prevent the proper registration of the instrument.

In conclusion it cannot be too strongly emphasized that the use of the thermometer as an aid in the detection of infectious disease is only of value when reliable and tested thermometers are available, and when great care is observed in their use. Where large numbers of thermometers are required for inspection there is always a temptation to purchase cheap or inferior thermometers as a matter of economy; this is always to be deprecated.

CHAPTER XIII

THE MOSQUITO

THE mosquito and the means which have been employed to exterminate it are very properly considered in connection with the subject of the prevention of infectious diseases inasmuch as it has already been conclusively proven that malarial fever and yellow fever are transmitted only by this insect, and reasonable evidence has also been presented to show that it is the medium of infection in other diseases.

Although it is only for the past few years that we have been in possession of definite knowledge regarding this subject, the parasitic origin of disease has not infrequently been referred to in the past. As far back as 1849, the transmission of malarial fever in this way was suggested by a distinguished American physician, Dr. John K. Mitchell, and afterwards in 1859, it was also referred to by Dr. Barnes, a surgeon of the United States Army.

THE MOSQUITO

Although other observers, both in this country and abroad, have from time to time admitted the possibility of this means of infection, it received but little consideration until 1880, when Dr. Laveran, a French army surgeon on duty in Algeria discovered in the blood of persons suffering from malarial fever an organism which he believed to be the cause of this disease. He announced his discovery to the Paris Academy of Medicine in 1881-82, and his statements were subsequently fully confirmed by investigators in different parts of the world. Laveran, as well as King, Bignami, Manson and others, was for various reasons led to believe that the mosquito might be the agent of transmission of this disease, and the subsequent exhaustive researches, particularly of Dr. Ronald Ross, furnished full and indisputable proof that malaria is transmitted by a variety of mosquito known as the "Anopheles," and so far as it is known, at the present time, in no other way.

The old theory that malaria is caused by miasma or poisonous emanations from swamps or low-lying districts, or by bad air, as the name malaria implies, had secured so firm a hold, not only upon the laity, but also the med-

PREVENTION OF INFECTIOUS DISEASES

ical profession, that it has been reluctantly abandoned and there are to-day some observers who, while admitting that the mosquito is a medium of infection of this disease, believe that there are other means by which malaria is transmitted. Thus far their theories and arguments are based neither on logical nor scientific research and are therefore not entitled to serious consideration. Unfortunately for mankind the "Anopheles" is so widely propagated that malaria is probably more generally disseminated than any other infectious disease.

Twenty years after Laveran published the result of his valuable researches regarding malaria, it was discovered that the mosquito is also the medium of infection in yellow fever. For years Dr. Carlos Finlay, a distinguished physician of Havana, insisted that in some way the mosquito was responsible for the transmission of this disease. He had observed that yellow fever was more active in years when mosquitoes were very numerous. He also presented other reasons in support of his theory; however, it received but little attention until the occurrence of the Spanish-American war, when the occupation of Cuba by the

THE MOSQUITO

United States troops made it imperative that this government should employ every means to protect its people against yellow fever. For the purpose of investigating the cause of this disease and the means by which it could be prevented, a Commission composed of Dr. Walter Reed, Surgeon, and Drs. Carroll, Agramonte, and Lazear, Assistant Surgeons, United States Army, was appointed by the President and directed to proceed to Cuba. Finlay's theory was brought to the notice of the Commission, and received prompt and careful consideration. It was followed by many important and exhaustive experiments and resulted in the presentation by the Commission of conclusive evidence that yellow fever is transmitted only by the mosquito, and furthermore only by one variety of this insect known as the "*Stegomyia Fasciata*." It was also shown that the clothing, bedding, discharges, etc., of yellow fever patients, which formerly were supposed to be active agents in the transmission of this disease, are harmless and in no way a menace to the public health. Unfortunately the specific organism, the cause of yellow fever, has not yet been identified.

It should be understood that the "Ano-

PREVENTION OF INFECTIOUS DISEASES

phes" and "Stegomyia" are as harmless as any other mosquito until after they have become infected by biting persons suffering from malaria and yellow fever. Even after this occurs they cannot immediately act as a medium of infection as there must be an interval for the development and transmission of the malarial and yellow fever organism in the body of the mosquito before it can be transmitted from this insect to the human being. This in the "Anopheles" takes about one week, and in the "Stegomyia" about two weeks.

It would be impossible to estimate the value to mankind of the discoveries just referred to. Probably no disease has caused more widespread suffering and loss of life than malarial fever, and although the area included in the yellow fever zone is very much more restricted than sections of the world where malaria exists, the loss of life, the injury to commerce, and in this country the interstate friction, which yellow fever has caused in the past are incalculable. The knowledge we now possess regarding the medium of infection in malaria and yellow fever has placed in our hands means which if properly employed will prevent, or bring promptly under control, outbreaks of

THE MOSQUITO

these diseases, and it is safe to say that the ravages which they have caused in the past need never occur again.

In addition to yellow fever and malaria, careful investigation has presented evidence that elephantiasis and probably other diseases which are due to the presence of filaria are also transmitted by the mosquito. There is also reason to believe that the mosquito may act as a medium of infection in bubonic plague. What future investigation will reveal to us in this direction will be determined largely by the energy displayed in following out the clues already in our possession.

Much valuable information has been secured regarding the mosquito; however, we need more complete knowledge regarding its habits, its method of propagation, life cycle, food, breeding places, etc. This study will naturally lead to the consideration of flies and other insects, which will undoubtedly be found to play an important part in the transmission of infectious disease. We have already learned enough to know that many of our theories regarding the means by which these diseases are transmitted are erroneous, and in order to deal successively with outbreaks, it is imperative

PREVENTION OF INFECTIOUS DISEASES

that we should secure all possible information regarding their real medium of infection.

While the "Anopheles" may be found in all parts of the United States, the "Stegomyia" or yellow fever mosquito is confined practically to the southern portion of it, and is not found in the northern section of this country, although if brought to the latter territory it will undoubtedly propagate during the summer months, but there is no reason to believe that it will hibernate or survive the winter; therefore, its reappearance will be due to a fresh importation.

The most recent investigation of the mosquito in the United States relates to the "Culex sollicitans," striped-legged, salt water or Atlantic coast mosquito, of which little has heretofore been known. This variety constitutes about 80 or 90 per cent of all mosquitoes found along the Atlantic coast, and is the chief source of annoyance in the section referred to.

Until recently the extermination of the mosquito has been regarded as practically impossible, and even within the past ten years the propagation of certain species of birds, etc., for the purpose of diminishing the number of these insects has been seriously sug-

THE MOSQUITO

gested by those whose opinions are entitled to consideration.

However, it is now known that the extermination of the mosquito is not only practical, but can be successfully accomplished. Besides it is now generally understood that the extermination of the mosquito is not alone for the purpose of preventing the annoyance which the bite of this insect inflicts, but also to prevent the transmission of disease. This has secured the coöperation of the public in this work—a most important consideration.

To obtain success in the extermination of the mosquito we must be familiar with the manner in which it is propagated, its habits, etc. It has been shown that all varieties of the mosquito propagate only in water and nowhere else. The great value of this knowledge lies in the fact that it gives us definite information regarding the character of their breeding places. The eggs deposited on the water develop into larvæ, commonly known as “Wigglers,” and then into “Pupæ,” which are subsequently transformed into the winged insects. From the deposit of the eggs to the development of the winged insects only twelve to twenty-five days elapse, depending on the

PREVENTION OF INFECTIOUS DISEASES

variety of the mosquito. The longest period is as a rule required for the development of the “*Anopheles*” or malaria mosquito. Climatic and other conditions also affect the period of propagation.

So far as it is known the male mosquito does not bite; therefore the female is responsible both for the annoyance which the bite of this insect involves, and also for the transmission of disease.

VARIETIES OF MOSQUITOES

For practical purposes mosquitoes in the United States may be divided into the “Inland” or fresh water mosquitoes, and the “Coast” or salt water swamp mosquitoes.

The “Inland” mosquito is the most common throughout the world, and includes many varieties, among which are those known to transmit disease, i.e., the “*Anopheles*” or malarial mosquito, and the “*Stegomyia*” or yellow fever mosquito.

The “Coast” mosquito refers principally to the “*Culex sollicitans*,” variously known as the “Atlantic Coast,” “striped-legged,” or “Salt-water swamp” mosquito. So far as it is known, this variety does not transmit disease.

THE MOSQUITO

PROPAGATION OF THE MOSQUITO

The "Inland" mosquito will breed in almost any receptacle containing water, commonly in pools, cisterns, rain-water barrels, tin cans and other metal, glass and wooden receptacles, roof leaders, crotches of trees and frequently in the most unsuspected places. The author's investigation has shown that the propagation of this mosquito, particularly the most common variety of it, known as the "*Culex pungens*," is as a rule most active in stagnant and offensive water which contains considerable organic matter. Two rather remarkable instances have recently come under the observation of the author where broken sewer pipes discharged their contents into ground depressions, resulting in collections of offensive water. In the immediate vicinity of these were pools of rain-water which were not specially contaminated. It was found that the sewer water soon became exceedingly rich in mosquito larvæ, whereas, in the other pools, but a short distance away, and which contained comparatively clear water, there were few, if any, larvæ found. The author's experiments furnished additional proof of this, as follows: Large superficial wooden

PREVENTION OF INFECTIOUS DISEASES

tanks were employed in which water of various kinds was placed, i. e., rain-water, hydrant-water, and water in which decomposed meat, fish, etc., had been added. These tanks were exposed side by side in a section infested with mosquitoes. In all the tests it was shown that the deposit of the mosquito eggs was always more numerous in tanks containing the offensive water. Experiments on a smaller scale were also made; pails and glasses were exposed, which contained the different kinds of water already referred to, with the same results: viz., the deposit of the eggs was much greater in the offensive water. These experiments were repeated many times with the same result, and are in harmony with the natural conditions which were found in districts infested with the "*Culex pungens*."

Thus far no evidence has been presented to prove that this or any other variety of the "Inland" mosquito will propagate in salt-water swamps—the breeding place of the "*Culex sollicitans*" or striped-legged mosquito.

While the "*Anopheles*" or malarial mosquito may sometimes be found breeding in the same receptacle with the "*Culex pungens*," it generally selects for its breeding place small pools

THE MOSQUITO

of water, commonly permanent ones, which are not contaminated and which are frequently covered with a green scum, or in water contained in small ground depressions along the edge of swamps or pools of water which are fed by springs.

The "*Culex sollicitans*" breeds only in salt-water swamps and in no other place. This statement has been proven by investigation and experimental work conducted by the author for the past ten years. During this period specimens of water containing larvæ taken from all kinds of receptacles about dwelling houses, ground depressions, etc., either in close proximity to, or some distance removed from salt-water swamps, were placed in large glass receptacles, covered with netting and allowed to remain until the winged insects were developed, but in no instance did the "*Sollicitans*" develop from the larvæ. A number of times larvæ were taken from inland drains, the immediate vicinity of which was thickly infested with the "*Sollicitans*," but the larvæ always developed into the "*Culex pungens*," or "*Inland*" mosquito. The result of these observations gradually directed attention to the salt-marshes along the coast as the seat of

PREVENTION OF INFECTIOUS DISEASES

propagation of the "*Culex sollicitans*." Here in the pockets or ground depressions containing water the larvæ of this variety were found in enormous numbers. By placing the water containing these larvæ in large glass jars covered with netting, it was found that when the winged insects appeared they were found always to be the "*Culex sollicitans*." The results to which I have referred are in harmony with the investigation of Prof. John B. Smith, State Entomologist of New Jersey, to whom great credit is due for exceedingly valuable work in connection with the mosquito and its extermination.

Careful investigation, therefore, shows that the "*Culex sollicitans*" breeds only in salt-water swamps and not inland or in fresh-water, while the "Inland" mosquito does not breed in salt-water marshes. Investigation has also shown that the "*Culex sollicitans*" hibernates in the form of the egg, which is deposited on the soft earth in the swamp late in the fall, and remains there until the warm weather of the following year appears, and then develops into the winged insect in the water which floods the swamp.

On the other hand, it is equally certain that

THE MOSQUITO

the “*Culex pungens*” and other varieties of the “Inland” mosquito are perpetuated by hibernation, during the winter, of the winged insects and not by their eggs. It is a frequent occurrence in sections where this latter variety of the mosquito breeds to find a few of them about the house during the winter months, particularly in well-heated apartments. When the warm weather appears they become active again and deposit their eggs in some receptacles containing water and then die. It is not impossible that a few of this variety may hibernate during the winter in the form of larvæ, as in some instances they have been detected in ice, warmed and brought to life. However, it is quite certain that the larvæ do not play an important part in the perpetuation of the mosquito.

As has already been stated, the mosquito can propagate only in water, which must be continuously present for about two weeks in order to allow the full propagation of the insect. If the water is withdrawn before the expiration of this time and is not returned within a few hours, propagation ceases. Therefore a temporary accumulation of water for two or three days only does not produce mos-

PREVENTION OF INFECTIOUS DISEASES

quitoes. Mosquito larvæ are not usually found in large bodies of water, although they are frequently present in the little pockets along their borders. In these situations the larvæ can be quiet and secure richer nourishment by remaining close to vegetation, which also furnishes them better protection.

After selecting a breeding place, the mosquito deposits its eggs on the surface of the water usually during the night, at which time they are most active. This is particularly so with the "Anopheles," therefore, it is true malaria is usually contracted at night time.

The common inland mosquito, "Culex pungens," will lay from 250 to 400 eggs at one time. The eggs are shaped somewhat like a banana, although one end is rather blunt. These are held upright and together in the form of a float or raft. From the lower or blunt end of these eggs, which rest on the surface of the water, the larvæ are released and drop into the water usually from 15 to 20 hours after the eggs are deposited. The "Anopheles," the "Stegomyia," and the "Culex sollicitans" do not lay their eggs in the form of rafts as in the case of the "Culex pungens," but separately on the surface of the water, and

THE MOSQUITO

not so many at one time. The mosquito larvæ are commonly known as "Wigglers." When full grown they are about one-quarter of an inch or more in length, with a large head, and may be seen moving about the water in a rapid and jerky way. Although they can live only in water, they are dependent on air for existence, and to obtain this must every minute or so rise to the surface of the water and project above it their caudal extremity, which contains a tube, the inlet of the respiratory apparatus. In other words, it may be said that the larvæ breathe through the tail. In observing this phenomenon in a glass of water it will be noticed that in securing the air the larvæ usually lie at right angles with the surface of the water with their caudal extremity protruded just above it. An exception to this occurs in the case of the "*Anopheles*" larvæ, which do not arrange themselves at this angle, but lie parallel with the under surface of the water. After the larvæ have been in the water for 8 or 10 days, sometimes longer, depending on the season of the year, temperature, also the variety of the mosquito, etc., they pass into what is known as the pupal stage, in which the head of the

PREVENTION OF INFECTIOUS DISEASES

larvæ is apparently enormously increased in size.

This stage lasts two or three days at the expiration of which time the pupæ, which generally remain close to the surface of the water and probably require no nourishment, burst the envelope which surrounds them and become winged insects. Contrary to a general belief, mosquitoes do not grow larger after their birth, but are of full size when they emerge from the pupal envelope.

FOOD

Mosquitoes are voracious eaters and the material which they use for food covers a wide range. Although the female draws blood, it may be said that mosquitoes live upon plants, fruits, etc. The larvæ derive their nourishment from the organic and other material in the water, therefore, if it is rich in this matter, it constitutes a very favorable breeding place. In this way filth plays not an unimportant part in the propagation of the mosquito.

LENGTH OF LIFE

Our present knowledge regarding the life cycle of the mosquito is by no means conclusive

THE MOSQUITO

or satisfactory as experiments in regard to this part of the subject cannot be carried out under normal conditions. However, as the result of careful observation it may be said that the average life of a mosquito when free is probably two or three weeks or even longer. This, however, is dependent upon many conditions. The author has kept them in captivity for two months with nothing but sugar and water for nourishment.

Aside from the value of securing definite knowledge relative to the length of time which mosquitoes live under ordinary conditions, the period which they may exist in close confinement and without air or light has a very important practical bearing, as it has been claimed that yellow fever may be transmitted from one place to another through the agency of the infected "*Stegomyia*," or yellow fever mosquito, confined in baggage, etc. In order to secure so far as possible definite information regarding this part of the subject, the following experiments were made by the author.

A number of boxes, canvas bags, and other receptacles were filled with clothing, blankets, bedding, etc. When these were made ready, mosquitoes were collected from horses taken

PREVENTION OF INFECTIOUS DISEASES

to a district thickly infested with mosquitoes; the insects were secured uninjured by placing a test tube over them. When a sufficient number were secured, the openings of the tubes were filled with light cotton plugs and within a short time afterwards were introduced into the receptacles already described, the cotton plugs removed, and the tubes gradually removed, being shaken sufficiently to drive out the mosquitoes. In this manner from the time of the capture of the mosquitoes until their introduction into the receptacles, they were neither handled nor in any way injured; certainly, no more than they would be if imprisoned during the process of packing. A careful record was kept of the number of mosquitoes in each receptacle in order that they could all be accounted for, and although many experiments were made, it was found that in no instance did the mosquitoes survive the confinement longer than thirty hours. These experiments furnished reasonable evidence that the treatment of baggage coming from yellow fever ports is unnecessary, provided the period of transit exceeds two days or even less time, for in the experiments referred to but few of the mosquitoes survived a period of twelve hours.

THE MOSQUITO

DISTANCE WHICH MOSQUITOES TRAVEL.

Considerable difference of opinion exists in regard to the distance which mosquitoes travel; however, careful investigation has shown that the "Inland" mosquito does not willingly go far from its breeding place and is notoriously a home mosquito, and remains in close proximity to its breeding place unless forcibly removed by winds, etc. This is well known to those who have studied the "*Stegomyia*" or yellow fever mosquito. There is no doubt that the difference of opinion which exists in reference to this part of the subject, particularly in regard to the variety just referred to, is due to the fact that the local breeding places are frequently overlooked. When it is remembered that the female of the "*Culex pungens*" variety will lay three or four hundred eggs at one time, and as it only requires from twelve to twenty-five days for eggs to develop into winged insects, it is not difficult to understand how a small receptacle will breed a large number of mosquitoes. Therefore, the most exhaustive investigation should be made to discover the breeding place before the search is abandoned, for they are often

PREVENTION OF INFECTIOUS DISEASES

found in the most unsuspected places. An instance occurring in the author's experience will illustrate this. A number of cases of malarial fever occurred in a certain section and in houses in close proximity to each other. "Anopheles" were found in the rooms of these dwellings during the evening. In the immediate vicinity of the houses were found numerous pools of water, rain-water barrels, and other receptacles containing water, which were examined with great care, but no "Anopheles" larvæ were found. Continued investigation was made, and in the garden of an adjoining vacant house was found an old cake pan almost entirely covered with long grass, and filled with "Anopheles" larvæ. An ordinary inspection would probably not have discovered this receptacle.

The "Culex sollicitans" or "striped-legged" mosquitoes, on the other hand, are always found some distance from their breeding place, and frequently go two or three miles or more into the interior. This can easily be proven by a careful inspection of the insect—the well-marked striped-legs of the "Culex sollicitans," and the stripe across the center of the proboscis of the female will identify this variety anywhere.

THE MOSQUITO

In 1900, the author began an investigation of the mosquito on Staten Island, with the intention of securing such information as would aid in the extermination of this insect. In the first experiment a space of about one mile square in the center and northern end of the Island was mapped out. This section was thickly infested with mosquitoes. Each house or building and its surroundings were carefully examined, and in this way innumerable breeding places were found. Land depressions acting as receptacles for water were, so far as possible, removed or treated with petroleum oil. Notwithstanding this, the results obtained during the summer of 1900 were not encouraging, as the number of mosquitoes was only slightly diminished. One thing was particularly noticed, that the mosquitoes found and captured were almost all of the "striped-legged" variety, but peculiarly enough, it was also found that the larvæ, which were removed from the receptacles above referred to, brought to the laboratory and placed under wire netting and allowed to propagate, never developed into the "striped-legged" mosquito. In other words, it was impossible in the beginning to find the breeding place of this insect, which

PREVENTION OF INFECTIOUS DISEASES

was always present in the greatest number. The fact that these mosquitoes were found in swarms along the coast suggested that somewhere in this vicinity the breeding places would be discovered, and further investigation proved this to be so and, also, that the breeding places of the mosquito that constitutes more than three-fourths of all those found on Staten Island, and along the entire Atlantic coast, and that is known as the "*Culex sollicitans*" or the "striped-legged" mosquito, are only in salt-water swamp land, and nowhere else.

The "*Culex sollicitans*" is present in such enormous numbers along the Atlantic coast, that the normal growth of towns in these sections and the comfort of those who seek permanent or summer residences in these places have been seriously interfered with. Just why these swamps constitute the only breeding place of this variety of the mosquito, is not definitely known. They are more or less constantly covered with water, and are favorable for breeding places. However, this does not offer full explanation, as fresh water accumulations not far from the coast do not act as the breeding place of the "*Culex sollicitans*."

THE MOSQUITO

The probable explanation is that salt-water vegetation contains some form of nourishment which is found in no other place, and is necessary to this variety of the mosquito.

Those who are not familiar with the vast extent of swamp land along the Atlantic coast, cannot form an adequate idea of the enormous breeding places which these great stretches afford. The tissue of the ground is always water-soaked and spongy, and surface water cannot properly escape. This insures a permanent accumulation of water, which generally appears in the form of patches or pockets, which constitute the breeding places of the "striped-legged" mosquito. Thus far, investigation has shown that this variety of the mosquito hibernates during the winter in the form of the egg, and not as the winged insect, as in the case of the inland mosquito. As it has already been stated, the eggs of the "Solicitants" are laid in soft earth of the swamp land during the fall, and when the water becomes warm again in the early summer, and the swamps are flooded, active propagation takes place. The author has in a number of instances verified this by experimental results.

PREVENTION OF INFECTIOUS DISEASES

The "Sollicitans" presents another exception, as it is the only variety we know of which voluntarily leaves its home, and is constantly found in large numbers far from its breeding places.

The knowledge we now possess regarding the "*Culex sollicitans*" or "striped-legged" mosquito clearly indicates the only means by which it may be exterminated, i. e., by the proper drainage of the swamp land, which acts as its breeding place.

The details of the investigation to which I have just referred were presented to the Department of Health of the City of New York in 1905, and on the recommendation of the said Department, the municipal government granted an appropriation for the drainage of the swamp land along the entire Staten Island coast and the work was begun in November, 1905, under the personal direction of the author.

The ditches were made about two feet deep, 10 to 12 inches wide, and from 50 to 200 feet apart. These connect with main drains, which singly or together discharge into the sea in order to secure a proper outlet of their contents. As this undertaking was practical pioneer work, the details were in a measure experi-

THE MOSQUITO

mental. The drainage was begun in the swamp land on the south and east sides of Staten Island. This work was performed principally by hand, although ditching machines were used in some portions of the swamp. The winter of 1905-06 being very mild, it was possible to continue the work without interruption, and before the breeding season of 1906 began, a large portion of the swamp land on the south side of Staten Island was drained.

In this section along the edges of the swamps are small summer resorts, South Beach and Midland Beach, which in the past have suffered severely on account of the great swarms of mosquitoes. Here the results of the drainage were found to be eminently successful. Equally good results were also obtained in sections further in the interior, which were formerly supplied with mosquitoes from the swamps in this locality. In other places where drainage had not been carried out, there was practically no diminution in the number of these insects. The work of ditching was continued during the remainder of 1906, and until the early part of 1907, when the drainage of the entire swamp land on both sides of Staten Island was completed.

PREVENTION OF INFECTIOUS DISEASES

A review of this work showed that, although all the contracts made for the drainage had been complied with, in many instances the ditches were not close enough together to effectively drain the land. Furthermore, it demonstrated that the proper policy to be followed in draining for the extermination of the mosquito is not to have the ditches at regular intervals, but to increase or decrease their number as the conditions in the different sections present themselves. In order to conform to this, and to more effectively drain the swamp land already gone over, an additional appropriation was asked for from the municipal government. This was granted and the re-ditching began in June, 1907, and was completed in 1909.

The land drained has entirely changed its character; instead of being soft and dangerous to walk upon, as before drainage it was unable to support the weight of the body, it is now firm and hard, and may be driven over by trucks. Salt-water hay found on these swamps, which is used for packing, etc., and worth about \$8 per ton, is now actively harvested in season. Therefore, drainage not only destroys the breeding places of the mosquito by allowing the surface water to escape

THE MOSQUITO

through the ground into the ditches, but it also reclaims the land for building and agricultural purposes. About 8 or 10 square miles of swamp land have been drained on Staten Island and the success of the drainage for the purpose of exterminating the mosquito is now practically assured.

The crusade against the mosquito on Staten Island has not been confined to the breeding place of the "*Culex sollicitans*," as active measures have been taken to exterminate the inland mosquito, of which the "*Anopheles*" or malarial mosquito is one of the varieties. Department of Health orders have been issued to remove breeding places from the premises, to repair defective roof leaders, cess-pools, etc. It is also required that rain-water barrels and cisterns, if they cannot be changed for more modern methods of obtaining water, shall be covered with wire netting.

Land depressions have been filled in or drained, or if this is not possible, the water contained is treated with petroleum. About fifteen thousand circulars have been distributed during the summer to the inhabitants explaining the means by which mosquitoes breed, the way in which they can be exterminated and re-

PREVENTION OF INFECTIOUS DISEASES

questing the aid of house owners and tenants in this work. The result has been particularly satisfactory. The number of inland mosquitoes has been greatly diminished and but very few of the "Anopheles" are now found.

THE EXTERMINATION OF THE MOSQUITO

The proper principle to follow in the extermination of the mosquito is, if possible, to remove or destroy breeding places and not to treat them. To secure success in the extermination of the "inland" mosquito, it is very important that the coöperation of house owners and tenants should be secured, and the work carried out under the direction of the health authorities. The most exhaustive inspection should be made to discover the breeding places and to remove them. If pools of water exist they should be drained or filled in. The question of stocking larger bodies of water with certain kinds of fish for the purpose of destroying the larvæ should not be considered. As a matter of fact, large bodies of water do not as a rule propagate mosquitoes. If the drainage or filling in of small collections of water cannot be properly carried out there is a means

THE MOSQUITO

of quickly destroying the larvæ present, which can always be depended upon, i. e., the application of petroleum oil, which is the most effective temporary agent we possess for this purpose. It kills them, not by poisoning, but by suffocation, as the oil on the surface of the water plugs up the end of the respiratory apparatus projected above it, and prevents the proper intake of air. Partly refined petroleum oil is preferable for this purpose as the crude oil does not easily or completely spread over the surface of the water. About one pint is sufficient for an estimated water space of 20 to 25 feet in diameter. There is no more effective or simple way of applying the oil than by the ordinary garden sprinkling pot with holes in the expanded nozzle enlarged so as to allow a free exit. This application should be repeated every ten days or two weeks as the oil does not remain equally distributed over the surface of the water, but is blown or otherwise carried to the edge of the pool. Petroleum oil is not only the most effective temporary agent for this purpose, but it is cheap and harmless. The use of a solution of bichloride of mercury, carbolic acid, permanganate of potassium, etc., for the destruc-

PREVENTION OF INFECTIOUS DISEASES

tion of mosquito larvæ may involve danger to persons or animals who come in contact with it or who may use water treated by these agents, and, therefore, should never be employed for the destruction of larvæ. Besides, these agents are comparatively expensive and act only slowly and imperfectly. The author's experiments showed that mosquito larvæ survived for 24 hours or more in a 1-2,000 solution of bichloride of mercury, and also in a comparatively strong solution of carbolic acid, permanganate of potassium and other agents.

The requirements for the successful extermination of the "*Culex sollicitans*" or "salt-water-swamp" mosquito are in marked contrast with those needed for the extermination of the "inland" variety, for it is required that the swamp land shall be thoroughly drained, and that this work shall be carried out under municipal, state or federal control in order to secure the drainage of the entire swamp land and not portions of it. Ditching here or there according to the will of the individual property owner will only end in failure, for if all the swamp land is not drained, the breeding places are not removed and the extermina-

THE MOSQUITO

tion of the mosquito does not take place. The use of petroleum oil on swamp land, which often involves vast areas, is practically worthless.

INDEX

- Aerial infection, 14
Agramonte, Dr., 237
Air, as germicidal agent, 217; as medium of infection, 14
Anopheles, arrangement of larvæ of, 249; breeding places of, 244; extermination of, in Staten Island, 261; malaria conveyed by, 236; manner of depositing eggs, 248; presence of, in all parts of United States, 240; time required for transmission of malaria by, 238
Autoclave, 184
Automatic counter, 51
Bacteriological examination, importance of, in diagnosis of infectious diseases, 21, 53; in malaria, 91; in suspected cholera cases, 111, 116, 121, 124, 125, 126
Barnes, Dr., transmission of malarial fever by mosquito referred to by, 234
Benzo phenol. *See* Carbolic Acid
Bichloride of mercury, disinfection of hands with, 18; disinfection of woodwork with, unnecessary, 217; method of obtaining, 196; objection to use of, as disinfectant, 197; poisonous properties of, 197; properties of, 196; uses of, in cholera, 118; value of, as a disinfectant, 151, 197
Bignani, belief of, in transmission of malarial fever by mosquito, 235
Boiling water, apparatus used for disinfection with, at New York Quarantine Hospital, 173; disinfection of discharges with, 117, 173, 213; disinfection of eating and drinking utensils with, 220

INDEX

- Books, as medium of transmitting disease, 221; method of disinfecting, 220, 221
- Bromine, as a deodorant, 205
- Buboes, importance of, in diagnosis of plague, 127, 132; presence of, not necessarily indicative of plague, 132
- Cabin passengers, infection not often transmitted by, 47; treatment of, in cholera, 112, 116; treatment of, in small-pox, 64; treatment of, in typhus fever, 106
- Carbolic acid, discovery of, 198; method of extracting, 198; properties of, 198; value of, as disinfectant, 151, 198
- Cargoes, disinfection of, 11, 97, 146, 219
- "Carriers," 5, 111, 119-121
- Carroll, Dr., member of Yellow Fever Commission, 237
- Chicken-pox, character of eruption in, 60; differential diagnosis between, and small-pox, 58-62
- Chloride of lime, combination of, with copper as deodorant, 202-210; disinfection of discharges with, 113; manner of obtaining, 201; manufacture of, 201; method of using, as disinfectant, 202; properties of, 201; value of, as disinfectant, 201
- Chlorine, dangers in use of, as disinfectant, 195
- Cholera, bacteriological examination in, 53, 111, 116, 121, 124, 125; carriers of, 111, 119, 121, 124, 125; danger of, from irregular cases, 53, 110; disinfection in, 113-118; fomites theory of, untenable, 110; incubation period of, 119-121; isolated cases of, 125; isolation in management of, 112, 113; organisms present in, 126; partial protection against, afforded by quarantine, 121; precautions against, on vessels from infected ports, 53, 111, 115; quarantine officials in danger of, 115; quarantine regulations concerning, 53, 111-125; sources of infection in, 53, 110, 114; sus-

INDEX

- pected cases of, 53, 111, 118-121, 124
- Cleanliness, importance of, in prevention of infectious diseases, 149; necessity for, among cholera suspects, 118; necessity for demonstration of, at quarantine station, 226
- Clothing, as medium of infection, 9, 11, 17, 147
- Coast mosquito, 242
- Copper, use of, as deodorant, 202-212
- Corrosive sublimate. *See* Bichloride of Mercury
- Crew of vessel, treatment of, at quarantine station, in cholera, 112; in plague, 130, 131, 138; in smallpox, 66; in typhus fever, 105; in yellow fever, 80, 81, 82
- Cuba, extermination of yellow fever in, 40; importation of yellow fever from, 85
- Culex pungens*, 243, 244, 247, 248, 253
- Culex sollicitans*, annoyance from, on Atlantic coast, 240; breeding-places of, 244, 245, 246, 256; deposition of eggs by, 248, 257; extermination of, 258; extermination of, in Staten Island, 202, 258; hibernation of, 257; migration of, 254; numbers of, on Atlantic coast, 256; reproduction of, 248
- Death certificates in cholera, 124
- Deodorants, 202-210
- Desquamation, as medium of infection, 15, 215; care during period of, 215
- Diphtheria, danger of infection in, 25; transmission of, among school-children, 11, 12, 14
- Discharges, disinfection of, 117, 133, 143, 147, 148, 149, 173, 213, 214; importance of, in transmission of disease, 147
- Disinfectant, air as a, 217; bichloride of mercury as a, 196; boiling water as a, 172, 220; chlorine as a, 195; formaldehyde as a, 181; lime as a, 199; meaning of word, 150; ozone as a, 194; soap and water as a, 2, 18, 216, 219, 220, 224, 225; steam

INDEX

as a, 153; sulphur dioxide as a, 176; sunlight as a, 217

Disinfectants, bacteriological investigation into value of, 150; essentials in, 152; manufacture of, 140; study of, 139

Disinfection, articles injured by, 170; earliest theories of, 139; ignorance concerning real significance of, 140-142; in cholera, 113; in plague, 133, 136; in small-pox, 63; in typhus fever, 107; in yellow fever, 96; inspection and isolation not supplanted by, 148; of apartments, 212; of bed, 216; of books, 220; of cargoes, 11, 97, 146, 219; of carpets, 216; of decomposing organic matter, 208; of discharges, 117, 133, 143, 147, 148, 149, 173, 213, 214; of eating utensils, 19, 219; of hands, 18; of mail, 170; of money, 145; of patient, 214; of privy vaults, 142; of rubber gloves, 20; of schools, 219; of sheets, napkins,

etc., 18; of ship's hold, 97, 136; value of, 148, 149, 151, 175; with bichloride of mercury, 196; with boiling water, 172, 213, 220; with chlorine, 195; with dry heat, 174; with formaldehyde gas, 181; with lime, 199; with ozone, 194; with steam, 153; with sulphur dioxide, 100, 136, 176

Dry heat as a disinfectant, 174

Egypt, rags in, not a source of infection, 8

Elephantiasis, transmission of, by mosquitoes, 229

Experiments, on steam as a disinfectant, 159; on sulphur dioxide as practical disinfectant, 178; on sulphur dioxide in extermination of rats, 181; to ascertain best method of exterminating mosquitoes, 255; to ascertain minimum increase of bodily temperature denoting abnormal condition, 227; to determine length of time mosquitoes can exist in close confinement, 251

INDEX

- Factories, examination of "suspects" in, 30
- Finlay, Dr. Carlos, transmission of yellow fever by mosquito suggested by, 236; theory taken up by Yellow Fever Commission, 237
- Fish, destruction of mosquitoes by means of, ineffectual, 262
- Fleas, agent in transmission of plague, 128, 132
- Fomites theory, 3-5, 6-9, 15, 110, 139, 237
- Food, possibility of infection through, in cholera, 114
- Formaldehyde gas, discovery of, 181; germicidal properties of, 181, 193; Robinson's apparatus for generating, 182; Trillat's apparatus for generating, 184; Walker's apparatus for generating, 186; value of, as disinfectant, 151, 193; comparative value of different methods of disinfection with, 190
- Fumigation, meaning of word, 150
- Gaseous disinfectants, 176; limitations to use of, 210; use of, at sea, objectionable, 218; use of, with carpets, questionable, 216; useless with books, 220
- Glands, examination of, in suspected cases of plague, 127, 132
- Gowns, as protection against infection, 18
- Hands, disinfection of, 18, 20, 148; importance of protecting, in cholera, 116; infection by means of, 148; protection of, by gloves, 20, 116; transmission of infection by, 17
- Harris, Dr., report by, on mortality of yellow fever, 86
- Health official, duty of, as regards infection, 20, 22
- Heat as a means of disinfection, 153
- Incubation period, importance of, in determining detention in infectious diseases, 46; length of, in cholera, 119; length of, in plague, 130; length of, in small-pox, 70

INDEX

Infectious diseases, bacteriological examination essential in diagnosis of, 53; cabin passengers not often media of infection in, 47, 64; care of, at sea, 34; "carriers of," 5, 111, 119-121; classification of, 23; control of, 16; desquamation not important in transmission of, 15, 215; difficulties in diagnosis of, 21; direct transmission of, 5, 15; duties of quarantine officials towards, 42; earliest theories of, 3; existence of, before Christian era, 24; expert knowledge of, essential in health officer, 20, 42, 52; extermination of, 40; fomites theory of, 3-5, 6-9, 15, 110, 139, 237; food and drink as means of transmission of, 5; germ theory of, discovered, 2; hands as means of transmission of, 10; mortality in, 24; nature of, controlled by quarantine, 38; nurses as means of transmission of, 17, 18; period of greatest infection in, 15; permanent

presence of, in some countries, 40, 41; persons as means of conveying, 5, 11, 15; physicians as means of conveying, 17, 18; prevention of, 13, 16; public health menaced by, 24; quarantine regulations against, 48-57; school-children as means of transmission of, 11; school inspection a protection against, 12, 25; secondary cases of, 27, 30; steerage passengers frequent means of transmission of, 47; "suspects" an important factor in spread of, 27, 30, 33, 53, 80, 118, 122, 125, 222, 232; tents in isolation of, 27

Inland mosquito, 242; extermination of, 262; hibernation of, 247; manner of propagating, 243; stationary habits of, 253

Jail fever. *See* Typhus fever

King, theory of, in transmission of malaria by mosquitoes, 235

Koch, 2, 150

INDEX

- Laveran, Dr., 235
 Lazear, Dr., 237
 Levitical laws on sanitation, 1
 Libraries, disinfection of, 221
 Lime, germicidal properties of, 199; manner of obtaining, 199; manner of using, 202; mixture of, with copper, 207; uselessness of using unslaked, 199; value as disinfectant, 202
 Mail, disinfection of, by steam, 170
 Malaria, organism of, discovered, 235; period of development of, in mosquito, 238; possibility of mistaking, for yellow fever, 91; transmission of, by mosquito, discovered, 235
 Manson, 235
 Marine sanitation, classification of diseases affected by, 38; difference between, and quarantine regulations, 36; duty of quarantine officials as regards, 43, 46; duty of ship-surgeon as regards, 45; importance of, 38; meaning of term, 36; relation of, to infected ports, 46; relation of, to passengers, 47, 52; relation of, to sick, 52; relation of, to suspected cases, 52; vigilance of, in connection with ports of departure, 37
 Measles, danger of, to public health, 25; early stage of, most infectious, 215; risk in transmission of, through desquamation probably exaggerated, 15, 215
 Mercuric chloride. *See* Bichloride of mercury
 Midland Beach, 259
 Mitchell, Dr. John, 234
 Money, as medium of infection, 10, 144; disinfection of, impracticable, 145
 Mosquitoes, breeding places of, 253; distance travelled by, 253; extermination of, 40, 262; food of, 250; impossibility of destroying, on ship-board, 96; larval stage of, 249; presence of infected, in baggage, etc., 94; presence of infected, on ship-board, 83-98; propagation of, 243; sum-

INDEX

- mer resorts infested by, 256; transmission of malaria by, discovered, 235; transmission of yellow fever by, discovered, 5, 40, 79; varieties of, 242
- Napkins as protection against infection, 18
- New York, epidemic of small-pox at, 7; epidemic of typhus fever at, 7, 27; epidemic of yellow-fever at, 85, 86, 87
- New York Health Department, appropriation for drainage on Staten Island recommended by, 258; inspection of public schools by, 11; method of preparing vaccine virus used by, 77; method of vaccination employed by, 76
- New York Quarantine Hospital, method of disinfection with boiling water at, 173; treatment of cholera discharges at, 117
- New York Quarantine Laboratory, bacteriological examination of intestinal discharges at, 125; experiments at, on destruction of rats with sulphur dioxide, 136, 181
- New York Quarantine Station, automatic counter used at, 51; blood examinations at, 91; history of infection on yellow fever ships received at, 91, 92, 93, 98; inspection of passengers at, 47; records at, concerning presence of infected mosquitoes on yellow fever ship, 84; use of thermometer at, 223, 224, 226
- Nurses, infection conveyed by, 17; necessity for, in isolation of infectious diseases, 26, 28; necessity for separate, in infectious diseases, 20; typhus among, 107
- Ozone as a disinfectant, 194
- Park, Dr. William H., 144
- Pasteur, 2, 150
- Perchloride of mercury. *See* Bichloride of mercury
- Permanganate of potash method, generation of formaldehyde gas by, 189, 193

INDEX

- Permanganate of potassium,
as a deodorant, 173
- Petroleum, use of, in exter-
mination of mosquitoes,
261, 263, 265
- Phenic acid. *See* Carbolic
acid
- Phenic alcohol. *See* Carbol-
ic acid
- Phenol. *See* Carbolic acid
- Physicians, as media of in-
fection, 17, 18; necessity
for school inspection by,
14
- Plague, buboes important in
diagnosis of, 127; disin-
fection comparatively un-
important in, 133; first
knowledge of, 40; glandu-
lar examination important
in suspected cases of, 127,
132; length of incubation
period in, 130; permanent
presence of, in India, 40;
pneumonic form of, trans-
mitted by discharges from
respiratory tract, 128;
ports of departure as
sources of infection in,
130; preventive measures
in, 133; quarantine regu-
lations against, 130-137;
sources of infection in,
other than rats, 129;
transmission of, by rats,
128
- Port, infected, definition of,
55; duty of health officer
to, 52, 56
- Ports of departure, duty of
quarantine officials to,
45, 56; importance of
vigilance at, 37; infection
from, in plague, 130
- Public health, principles of
sanitary science essential
to preservation of, 21;
protection of, against in-
fectious diseases, 20; pro-
tection of, against "sus-
pects," 29
- Public health officials, bac-
teriological examination
part of duty of, 21; care
in diagnosis essential to,
21; knowledge of infec-
tious diseases requisite in,
20; knowledge of sanitary
science requisite in, 21
- Pupæ, mosquito, 241, 250
- Quarantinable diseases, 23
- Quarantine, definition of,
36; difference between,
and marine sanitation,
36; diseases dealt with by,
38; earliest instances of,

INDEX

23, 36; efforts to avoid, 31

Quarantine officials, duties of, in plague, 131; duties of, in small-pox, 66, 69, 70, 75; duties of, in typhus fever, 102, 106, 108; duties of, in incubation periods, 46; duties of, in infectious disease occurring in transit, 45; duties of, regarding vessels from infected ports, 52, 56; efforts made to deceive, 51; expert knowledge essential in, 42, 52; limit to duty of, 48; risk of infection to, in cholera, 115

Quarantine regulations, accuracy in counting persons coming under, 51; against cholera, 110-126; against plague, 127, 130-138; against small-pox, 62-75; against typhus fever, 103-108; against yellow fever, 79-83, 97, 100; bacteriological examination important in, 53; concerning cabin passengers, 47, 49; concerning crews, 38, 48, 51, 52; concerning incoming vessels, 52; concerning infected ports, 37, 55; con-

cerning ships without surgeons, 50; concerning steerage passengers, 47, 49; concerning suspected cases, 30-34, 52, 55, 58; difficulty of bringing children under, 25; first establishment of, 36; impossibility of complete protection by, 48; improvement needed in, 37; stringency of, for Eastern countries, 41; uniformity of, impossible, 41; vaccination under, 70-77; visual examination under, 50

Quarantine station, at New York. *See also under* New York; detention of vessels at, unusual, 54; first establishment of, 24, 36; laboratory at, essential, 54; modern equipment at, a necessity, 42; nature of diseases dealt with, at, 38; treatment of persons detained at, 54; use of thermometer at, 224; vaccination at, 71

Rags, as medium of infection, 8; impossibility of disinfecting, while in bales, 146

INDEX

- Rats, destruction of, on ship-board, 134; experiments on destruction of, by sulphur dioxide, 136, 181; transmission of plague by, 128; transmission of plague by other means than, 129, 133
- Reed, Dr. Walter, 237
- Robinson, Prof. F. C., lamp devised by, 182
- Ross, Dr. Ronald, 235
- Rubber gloves, prevention of infection through hands by, 20; use of, in cholera, 116
- Rubber over-shoes, use of, in cholera, 116
- Runge, discoverer of carbolic acid in coal tar, 198
- Sanitation, early views upon, 1; marine, *see* Marine Sanitation
- Scarlatina, danger from desquamation in, exaggerated, 215; early stage of, most infectious, 215; importance of, 25; transmission of, among school-children, 11, 12
- School-children, necessity for examination of, against infection, 11, 25; transmission of infection among, 11-13
- School-teachers, not qualified to carry out preventive measures against infection, 14
- Schools, closure of, to prevent spread of infectious diseases unnecessary, 13; evidence regarding infectious disease given by, 11; official examination for infectious diseases in, 12, 13, 25
- Sheets, as protection against infection, 17
- Ship-fever. *See* Typhus fever
- Ship officers, quarantine regulations concerning, in plague, 131; in small-pox, 63; in typhus fever, 105
- Ship-surgeon, duty of, in infectious diseases in general, 32, 33, 34, 35; duty of, in cholera, 113; expert knowledge of infectious diseases not essential for, 52; value of report by, 45
- Small-pox, character of eruption in, 59; diagnosis between, and chicken pox, 58; diagnosis of, 32, 58;

INDEX

- disinfection for, 63; epidemics of, in New York, 7; fomites theory of, untenable, 7; incubation period in, 70; method of preparing vaccine virus for, 77; method of vaccinating for, 76
- Smith, Prof. John B., 246
- Soap and water, as a disinfectant, 18, 149, 215, 216, 225
- South Beach, 259
- Staten Island, drainage along coast of, 258; varieties of mosquitoes upon, 261
- Steam disinfecting apparatus, 153-157; precautions to be taken in use of, 171
- Steam disinfection, experiments in, 157-169; of books, 220; of mail, 170
- Steamship company, action of, as regards infectious diseases, 33
- Steerage passengers, in cholera, 114; in plague, 130, 131; in small-pox, 67-69; in typhus fever, 103-106; in yellow fever, 80, 81, 82; infection commonly transmitted by, 31, 47, 103; vaccination of, 74
- Stegomyia fasciata*, habitat of, 82, 83, 84, 87, 240; hibernation of, 87, 247; length of life of, 251; length of time required for development of yellow fever organism in, 238; non-migratory habits of, 90, 95, 253; presence of, on ship-board, 88-98; propagation of, 243, 248; transmission of yellow fever by, 5, 79, 237; variety including, 242
- Stewards and stewardesses, as assistants at quarantine station, 224; as nurses on ship-board, 34; detention of, at quarantine station, 105; vaccination of, 156
- Sulphur dioxide, annoyance caused by, to respiration, 141, 176; injury to cotton fabrics from use of, 179; method of generating, 179; oldest of all disinfectants, 176; use of, in plague, 134; use of, in small-pox, 68; use of, in typhus fever, 108; use of, in yellow fever, 97, 100; value of, as a disinfectant, 151, 177-181

INDEX

- Sunlight, as disinfectant, 217
- "Suspects," bacteriological examination of, important, 53, 118, 125; classification of, 27; daily examination of, 29; in cholera, 118, 122; in yellow fever, 80; isolation of, 33; quarantine regulations concerning, 30, 32, 122; use of thermometer in detecting infection in, 29, 30, 222, 232
- Tables showing results of investigation as to influence of vacuum in securing rapid high temperatures in steam disinfection, 159, 160, 161, 162; minimum increase of bodily temperature showing departure from normal, 227, 228; mortality in yellow fever, 86; value of steam as a disinfectant, 164, 165, 166, 167, 168
- Temperature, bodily, diagnostic value of elevation in, 28, 29, 30, 80, 99, 118, 132, 222, 223; exposure to intense heat not necessarily followed by increase of, 229; elevation of, in typhus fever, 102; increase in, of little value in diagnosis of cholera, 118; method of taking, at New York Quarantine Station, 224; minimum increase of, denoting abnormal condition, 226; minimum increase of, requiring detention at quarantine, 232; reliable instrument necessary, as diagnostic test, 233; tests made at New York Quarantine Station, to show minimum temperature denoting illness, 227
- Tennant and Knox, chlorinated lime first prepared by, 201
- Tents, isolation of infectious disease by means of, 27
- Textile fabrics, disinfection of, 197
- Thermometer, clinical, deception practised with, 233; diagnostic value of, 28, 29, 30, 80, 99, 118, 132, 222, 223; large number of, required by quarantine officials, 224; little value of, in diagnosis of cholera, 118; method of

INDEX

- using, at New York Quarantine Station, 224; necessity for use of, in mouth, 223; reliable instrument necessary to diagnostic value of, 233; soap and water sufficient for cleanliness of, 225
- Townsend, Dr., 86
- Trillat, experiments by, on germicidal properties of formaldehyde gas, 181; method of, for generating formaldehyde, 184
- Tuberculosis, classification of, among diseases, 23; transmission of infection in, 25
- Typhoid fever, classification of, among diseases, 23; disinfection of stools in, 143, 144; transmission of infection in, 25
- Typhus fever, classification of, among diseases, 23; disinfection in, 107; epidemics of, in New York, 7, 27; high temperature in, 102; incubation period in, 108; invasion of, 102; isolation of, 24, 27, 104; management of, on shipboard, 104; mortality from, 24; quarantine regulations against, 102, 108; stringent precautions necessary against, 102, 105
- Vaccination, care in performance of, 76; immunity secured by, 71; importance of, 71; of cabin passengers, 65; of crew, 64, 66, 67; of persons immediately exposed to infection, 73; of steerage passengers, 66, 74; on shipboard, 35, 70; proper time for, 72
- Vaccine virus, method of preparing, 77; method of using, 76; purity of, essential, 76
- Varicella. *See* Chicken-pox
- Venice, quarantine station at, 24, 36
- Wadsworth, James W., 155
- Walker, Mr. Henry V., 186, 187, 192
- Walker method of generating formaldehyde gas, 186, 192, 193, 201
- Wrigglers, 241, 249
- Yellow fever, disinfection for, unnecessary at quarantine, 79; epidemics of,

INDEX

in New York, 85, 86, 87, 89; extermination of, in Cuba, 40; history of, in New York, 85; increase of temperature important in detection of, 80, 99; incubation period in, 81, 99; management of, at ports outside of yellow fever zone, 81; management of, at ports within yellow

fever zone, 82; mild and unrecognized cases of, a source of infection, 98; mortality from, 24, 86, 238; mosquitoes infected with, not present on ship-board, 83-100; quarantine regulations against, 79-83; transmission of, by mosquito established, 5, 79, 236

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